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TURERS COUNCIL ON COLOR AND APPEARANCE

NBSIR 80-1827

COLLABORATIVE REFERENCE PROGRAM

COLOR AND APPEARANCE

COLOR AND COLOR DIFFERENCE

REPORT NO. 30

U.S. DEPARTMENT OF COMMERCE

National Bureau of Standards

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1980

NBS COLLABORATIVE REFERENCE PROGRAMS

TAPPI Paper and Board (6 times per year)

- Bursting strength
- Tearing strength
- Tensile breaking strength
- Elongation to break
- Tensile energy absorption
- Folding endurance
- Stiffness
- Air resistance
- Grammage
- Smoothness
- Surface pick strength
- K & N ink absorption
- Moisture content
- Opacity
- Blue reflectance (brightness)
- Specular gloss, 75°
- Thickness
- Concora (flat crush)
- Ring crush

FKBG-API Containerboard (48 times per year)

- Mullen burst of linerboard
- Concora test of medium

MCCA Color and Appearance (4 times per year)

- Gloss at 60°
- Color and color difference

CTS Rubber (4 times per year)

- Tensile strength, ultimate elongation and tensile stress
- Hardness
- Mooney viscosity
- Vulcanization properties

ASTM Cement (2 times per year)

- Chemical (11 chemical components)
- Physical (15 characteristics)

AASHTO Bituminous

- Asphalt cement (2 times per year)
- Cutbacks (once a year)

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COLOR AND APPEARANCE

COLLABORATIVE REFERENCE PROGRAM FOR COLOR AND APPEARANCE

COLOR AND COLOR DIFFERENCE

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U. S. DEPARTMENT OF COMMERCE
National Bureau of Standards

NBSIR 80-1827

INTRODUCTION

The NBS-MCCA Collaborative Reference Program for Color and Appearance is sponsored by the Manufacturers Council on Color and Appearance and the National Bureau of Standards. Four times per year, paint chip samples and near white paper samples, along with a white calibration check sample, are distributed to participating laboratories. Participants in the paint chip test receive two pairs of color samples (from the full color spectrum) along with a white calibration samples. Participants in the near white paper test receive two sets of eight near white papers along with a white calibration sample. Laboratories can participate in either or both tests. The samples are tested by the laboratories and the data is returned to NBS for analysis.

Each test is analyzed in both X,Y,Z and L,a,b color spaces. The X,Y,Z space analysis is primarily for spectrophotometers while the L,a,b space analysis is primarily for colorimeters. A laboratory must specify in which space it wishes to receive its analyses.

Data from each laboratory is processed in a "normal" and an "adjusted" analysis. In the "normal" analysis, the laboratory's data is used as reported. In the "adjusted" analysis, the laboratory's data is first adjusted using a correction factor generated from the laboratory's white calibration sample data (see Explanation of Data For White Sample).

For comparison purposes, a plot of the spectrophotometric curves of single paint chip specimens was provided by Hemmendinger Color Laboratory, Belvedere, New Jersey.

If there are any questions on the notes, analyses, or the report in general, contact Jeffrey Horlick or Thomas Cummings on (301) 921-2946.

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KEY TO TABLES

MEAN - The average of individual test determinations.

GRAND MEAN - (GR. MEAN) The average of the individual laboratory MEANS, excluding laboratories flagged (see column F) with an X, #, or +.

SD OF MEANS - The standard deviation of the laboratory MEANS about the GRAND MEAN: an index of the among-laboratory precision.

INST CODE - Code for instrument type and color space used to report measurements, see Table of Instrument Codes

F - Flag, is based on ΔE column with the following meaning:

0 - Included in grand mean analysis.

* - Included in grand means but results are between two and three standard deviations. The participants should take this as a warning to reexamine testing procedures.

X - Excluded from all calculations because ΔE is beyond (3) standard deviations.

\+ - Excluded from all grand mean calculations because lab is using a nonstandard instrument or test method.

\# - Excluded from all grand mean calculations because data were not understood, data were extreme, late, or insufficient information was supplied concerning instrument and test method used.

Note: In addition to flag (F) based on delta E column, it is also possible to have either an X or an * on individual MEANS as follows:

X - following a MEAN signifies that the mean is greater than 3 SD of MEANS from the Grand Mean. The values for this laboratory have been omitted in the calculations involving the MEAN for the column.

* - following any of the MEANS signifies that the quantity is greater than 2 but less than 3 of the appropriate standard deviations from the corresponding average. The participant should take this as a warning to reexamine his testing procedures.

ΔE - Total color difference between two samples. In X, Y, Z analysis it is calculated in MacAdams (FMC II) units. For L, a, b analysis it is calculated in Hunter units.

ΔE Calculation

ΔE is calculated in the Color and Color Difference Collaborative Reference Program by the FMC2* equations (X, Y, Z analysis) as follows:

The yellow-blue chromatic difference is

$$\Delta C_1 = K_1 S(P\Delta P + Q\Delta Q)/bD^2 - K_1\Delta S/b;$$

the lightness difference is

$$\Delta L = 0.279K_2(P\Delta P + Q\Delta Q)/aD;$$

and the red-green chromatic difference is

$$\Delta C_3 = K_1(Q\Delta P - P\Delta Q)/aD.$$

The quantity, D, is an abbreviation,

$$D = (P^2 + Q^2)^{1/2}.$$

$$K_1 = 0.55669 + 0.049434\,Y - 0.82575\cdot10^{-3}Y^2 + 0.79172\cdot10^{-5}Y^3 - 0.30087\cdot10^{-7}Y^4,$$

$$K_2 = 0.17548 + 0.027556\,Y - 0.57262\cdot10^{-3}Y^2 + 0.63893\cdot10^{-5}Y^3 - 0.26731\cdot10^{-7}Y^4,$$

$$a^2 = 17.3\cdot10^{-6}(P^2 + Q^2)/[1 + 2.73P^2Q^2/(P^4 + Q^4)],$$

$$b^2 = 3.098\cdot10^{-4}(S^2 + 0.2015\,Y^2)$$

$$P = 0.724\,X + 0.382\,Y - 0.098\,Z,$$

$$Q = -0.48\,X + 1.37\,Y + 0.1276\,Z,$$

$$S = 0.686\,Z,$$

$$\Delta E = [(\Delta C_1)^2 + (\Delta L)^2 + (\Delta C_3)^2]^{1/2}$$

*Friele-MacAdam-Chickering metric

NBS-MCCA COLLABORATIVE REFERENCE PROGRAM

TEST METHOD CODES

FOR PAINT CHIPS AND NEAR WHITE PAPERS

INSTRUMENT CODE PAINT	PAPER	INSTRUMENT	COLOR SPACE	DATA CODE
C70AC	C71AC	ACS SPECTRA SENSOR	X Y Z	9014
C70BL	C71BL	B+L 505 SPECTROPHOTOMETER	X Y Z	9014
C70CA	C71CA	CARY 14	X Y Z	9014
C70CD	C71CD	COLOR EYE SMALL SPHERE	X Y Z	9014
C70CE	C71CE	COLOR EYE SMALL SPHERE	XX'YZ,4V	9016
C70CF	C71CF	COLOR EYE SMALL SPHERE	XYZ,BaSO4	9017
C70CG	C71CG	COLOR EYE SMALL SPHERE	XX'YZ,Ba	9018
C70CH	C71CH	COLOR EYE SMALL SPHERE	XYZ,3V	9011
C70CL	C71CL	COLOR EYE LARGE SPHERE	XX'YZ,4V	9016
C70CM	C71CM	COLOR EYE LARGE SPHERE	XX'YZ,Ba	9018
C70CN	C71CN	COLOR EYE LARGE SPHERE	XYZ,BaSO4	9017
C70DC	C71DC	DIANO CHROMASCAN SPECTROPHOTOMETER	X Y Z	9014
C70DH	C71DH	DIANO MATCH SCAN SPECTROPHOTOMETER	X Y Z	9014
C70DK	C71DK	DIANO/LSCE AUTOMATE	XYZ,BaSO4	9017
C70DL	C71DL	DIANO/LSCE AUTOMATE	XYZ,3V,4F	9019
C70DM	C71DM	DIANO/LSCE AUTOMATE	XX'YZ,4V	9016
C70DS	C71DS	DIANO/SSCE AUTOMATE	XX'YZ,Ba	9018
C70DT	C71DT	DIANO/SSCE AUTOMATE	XYZ,BaSO4	9017
C70GA	C71GA	GARDNER AUTO AC2/AC3	L a b	9013
C70GB	C71GB	GARDNER AUTO AC2/AC3	X Y Z	9014
C70GC	C71GC	GARDNER XL-20/XL-30 SERIES	X Y Z	9014
C70GD	C71GD	GARDNER XL-20/XL-30 SERIES	L a b	9013
C70GE	C71GE	GE/DIANO/HARDY SPECTROPHOTOMETER	X Y Z	9014
C70GK	C71GK	GARDNER XL-70	X Y Z	9014
C70GL	C71GL	GARDNER XL-70	L a b	9013
C70GM	C71GM	GARDNER MULTIPURPOSE REFLECTOMETER	X Y Z	9014
C70GP	C71GP	GARDNER XL-200 SERIES	L a b	9013
C70GX	C71GX	GARDNER XL-10	L a b	9013
C70GY	C71GY	GARDNER XL-10	X Y Z	9014
C70HA	C71HA	HUNTER D25A (DA,D1A,D2A)	L a b	9013
C70HB	C71HB	HUNTER D25A (DA,D1A,D2A)	X Y Z	9014
C70HF	C71HF	HUNTER D25AA	L a b	9013
C70HG	C71HG	HUNTER D25AA	X Y Z	9014
C70HM	C71HM	HUNTER D25M (DM,D1M,D2M)	L a b	9013
C70HN	C71HN	HUNTER D25M (DM,D1M,D2M)	X Y Z	9014
C70HP	C71HP	HUNTER D25P (DP,D1P,D2P)	X Y Z	9014
C70HQ	C71HQ	HUNTER D25P (DP,D1P,D2P)	L a b	9013
C70HR	C71HR	HUNTER D25A (DA,D1A,D2A)	Rd a b	9012
C70HT	C71HT	HUNTER D54 SPECTROPHOTOMETER	X Y Z	9014
C70HU	C71HU	HUNTER D54 SPECTROPHOTOMETER	L a b	9013
C70IB	C71IB	IBM SPECTROPHOTOMETER	X Y Z	9014
C70KC	C71KC	KCS-18	XX'YZ,4V	9016
C70KD	C71KD	KCS-18	XX'YZ,Ba	9018
C70KS	C71KS	KCS-18	X Y Z	9014
C70KT	C71KT	KCS-40	X Y Z	9014
C70LS	C71LS	LERES TRILAC	X Y Z	9014
C70LT	C71LT	LERES TRILAC	XYZ,3V	9011
C70MD	C71MD	MACBETH MS2000 SPECTROPHOTOMETER	X Y Z	9014
C70ME	C71ME	MACBETH MS2000 SPECTROPHOTOMETER	L a b	9013
C70MG	C71MG	MACBETH MC1010	L a b	9013
C70MH	C71MH	MACBETH MC1010	X Y Z	9014
C70MS	C71MS	MARTIN SWEETS	X Y Z	9014
C70MT	C71MT	MARTIN SWEETS	XX'YZ,Ba	9018
C70ND	C71ND	NEOTEC 220 DU COLOR	R G B	9015
C70NE	C71NE	NEOTEC 220 DU COLOR	X Y Z	9014
C70SA	C71SA	SPECIAL INSTPUMENT - INCLUDED	X Y Z	9014
C70SB	C71SB	SPECIAL INSTRUMENT - INCLUDED	Rd a b	9012
C70SC	C71SC	SPECIAL INSTRUMENT - INCLUDED	L a b	9013
C70SL	C71SL	SPECIAL INSTRUMENT - INCLUDED	R G B	9015
C70SP	C71SP	SPECIAL INSTRUMENT - EXCLUDED	X Y Z	9014
C70SQ	C71SQ	SPECIAL INSTRUMENT - EXCLUDED	Rd a b	9012
C70SR	C71SR	SPECIAL INSTRUMENT - EXCLUDED	L a b	9013
C70SS	C71SS	SPECIAL INSTRUMENT - EXCLUDED	R G B	9015
C70ZD	C71ZD	ZEISS DMC25	X Y Z	9014
C70ZE	C71ZE	ZEISS ELREPHO	X Y Z	9014
C70ZF	C71ZF	ZEISS ELREPHO	R G B	9015
C70XX	C71XX	GIVE INSTRUMENT MAKE AND MODEL	NOT SPECIFIED	9020

FORMAT OF COLORIMETRIC (INPUT) DATA

DATA CODE	COLOR SCALE
9011	X,Y,Z 3 FUNCTION VITROLITE CORRECTION
9012	Rd,a,b
9013	L,a,b HUNTER
9014	X,Y,Z
9015	R,G,B
9016	X,X',Y,Z 4 FUNCTION VITROLITE CORRECTION
9017	X,Y,Z, BaSO4 CORRECTION
9018	X,X',Y,Z BaSO4 CORRECTION
9019	X,Y,Z 4 FUNCTION VITROLITE CORRECTION
9020	(NON-STD. INST. SCALE SPECIFIED WITH DATA)

Notes on Specific Laboratory Results for Paint Chips

C233	- Reported insufficient data to be analyzed in this report
C462A, C543	- Data appears in body of report, but corrections were made too late to be included in the statistical computation
C480	- Reported extreme values compared to other labs on mean Z for samples D13 and D14
C496B	- Reported extreme values compared to other labs on mean b for all five samples
C499	- Reported extreme values compared to other labs on mean b for the four colored samples
C512, C656, C402 C521A	- Data received too late to be analyzed in this report
C514A, C514B, C662, C717A, C717B, C720A, C720B, C727A, C727B	- Used illuminant D65
C705, C742	- Apparent reporting or measurement problem on all five samples
C716	- Data received too late to be included in Grand Mean Statistics
C721	- Reported extreme values compared to other labs on mean X and Y for samples D15 and D16
C742	- Used illuminant A

MCCA COLLABORATIVE REFERENCE PROGRAM
X, Y, Z SPACE ANALYSIS, NORMAL DATA
COLOR • COLOR DIFFERENCE
FOR PAINT CHIPS

LAB CODE	F	SAMPLE D13 MEAN X	MEAN Y	MEAN Z	SAMPLE D14 MEAN X	MEAN Y	MEAN Z	DIFFERENCE D14 - D13 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C157	A	65.01	59.89	25.78	64.93	59.54	25.67	-.08	-.35	-.11	1.92	70GE	C157
C162	A	66.13	61.12*	26.91	65.97	60.64*	26.40	-.16	-.48	-.11	2.20	70DC	C162
C251	A	65.02	58.20	25.39	64.72	57.50	25.04	-.30	-.70	-.35	3.27*	70SA	C251
C253	A	65.17	58.92	25.96	64.93	58.36	25.79	-.24	-.56	-.19	2.46	70GC	C253
C278	A	65.35	59.70	26.75	65.20	59.30	26.85	-.15	-.40	.10 *	1.67	70NE	C278
C407	A	65.26	59.89	26.45	65.14	59.43	26.25	-.12	-.45	-.18	2.44	70BL	C407
C414	A	63.61	57.97	25.24	63.48	57.53	25.11	-.13	-.45	-.13	2.33	70MD	C414
C416A	A	66.13	59.54	25.33	65.75	58.87	25.10	-.38	-.67	-.23	2.42	70IB	C416A
C416B	A	64.85	58.62	25.04	64.56	58.02	25.47	-.28	-.59	-.17	2.40	70GE	C416B
C418	A	63.10	58.69	28.03*	62.91	58.06	27.78*	-.19	-.63	-.25	3.27*	70CE	C418
C422	A	63.27	57.09	25.15	63.00	56.49	24.89	-.27	-.61	-.26	2.71	70SA	C422
C424	A	63.64	58.51	26.03	63.33	57.92	25.80	-.31	-.59	-.24	2.29	70CA	C424
C428	A	64.99	59.08	25.69	64.90	58.65	25.61	-.09	-.43	-.09	2.40	70HB	C428
C437	A	64.31	58.06	25.07	64.00	57.43	25.43	-.31	-.63	-.24	2.55	70GC	C437
C443	A	65.65	60.15	25.81	65.45	59.56	25.61	-.20	-.59	-.20	2.82	70CL	C443
C444	A	64.60	59.11	26.00	64.21	58.43	25.58	-.38	-.68	-.42 *	2.63	70GE	C444
C446	A	64.02	58.45	25.70	63.80	57.92	25.57	-.22	-.53	-.13	2.31	70GE	C446
C451	A	65.03	59.20	25.53	64.86	58.68	25.25	-.18	-.52	-.28	2.72	70AC	C451
C459	A	63.51	57.94	25.16	63.14	57.29	25.07	-.37	-.65	-.11	2.22	70GE	C459
C460	A	64.41	58.97	25.22	64.22	58.48	25.30	-.19	-.49	.09	2.01	70GE	C460
C462A	#	65.25	59.95	25.45	65.15	58.55	25.45	-.10	-.40	.00	2.06	70BB	C462A
C463	A	65.03	59.38	25.79	64.83	58.85	25.69	-.20	-.53	-.11	2.42	70ZD	C463
C469	A	64.56	59.22	26.04	64.43	58.61	25.86	-.15	-.61	-.18	3.30*	70GE	C469
C470	A	66.41*	61.28*	26.99	66.09*	60.69*	26.96	-.31	-.59	-.03	1.96	70DH	C470
C472	A	64.46	59.03	26.02	64.12	58.41	25.87	-.34	-.63	-.15	2.21	70ZD	C472
C473	A	65.13	59.82	25.84	64.95	59.30	25.67	-.19	-.51	-.17	2.43	70DH	C473
C474	A	63.83	58.17	25.74	63.67	57.74	25.71	-.15	-.43	-.03	1.96	70SA	C474
C476	A	64.24	58.57	25.55	64.05	58.09	25.61	-.19	-.48	-.07	2.10	70SA	C476
C480	A	63.78	57.93	17.41X	63.59	57.53	17.45X	-.19	-.40	.04	1.51*	70HB	C480
C481	A	64.90	59.05	25.45	64.65	58.55	25.35	-.25	-.50	-.10	1.90	70HB	C481
C482	A	63.61	57.53	25.18	63.36	56.96	25.01	-.25	-.57	-.17	2.49	70GC	C482
C483	A	64.60	57.50	25.04	64.25	56.75	24.80	-.35	-.75 *	-.24	3.18*	70SL	C483
C495	A	64.78	59.11	25.82	64.66	58.69	25.71	-.10	-.43	-.12	2.33	70KS	C495
C496A	A	65.07	59.44	26.11	65.06	59.12	26.10	-.01 *	-.32	-.01	2.07	70GE	C496A
C499C	X	64.83	58.53	26.94	63.96	57.20	26.40	-.87 X	-1.33 X	-.54 X	4.15X	70BL	C499C
C508	A	64.67	59.31	25.75	64.56	58.93	25.83	-.11	-.38	.05	1.81	70GE	C508
C511	A	64.48	58.89	25.71	64.33	58.44	25.61	-.15	-.45	-.10	2.16	70DH	C511
C512	#	65.31	59.62	25.44	65.14	59.17	25.45	-.18	-.45	.01	1.91	70AC	C512
C514B	•	63.53	59.28	24.16	63.22	58.66	24.07	-.31	-.62	-.11	2.28	70SP	C514B
C524	A	65.39	59.59	26.26	65.08	58.94	25.88	-.32	-.66	-.38	2.76	70GE	C524
C526	A	64.84	59.04	25.89	64.67	58.55	25.81	-.17	-.49	-.08	2.23	70KS	C526
C528	A	63.50	58.11	25.44	63.33	57.65	25.30	-.17	-.46	-.14	2.17	70MD	C528
C529	A	62.97	58.33	23.80	62.78	57.81	23.60*	-.18	-.53	-.25	2.63	70DB	C529
C534	A	63.84	58.06	25.33	63.64	57.66	25.40	-.20	-.41	.05	1.48*	70MD	C534
C536	A	62.13*	56.15*	24.10*	61.65*	55.60*	22.98*	-.28	-.55	-.12	2.09	70AC	C536
C540	A	64.63	58.85	26.00	64.40	58.29	26.22	-.23	-.57	-.11	2.45	70GE	C540
C543	A	64.97	59.30	25.80	64.84	58.84	25.79	-.13	-.46	-.06	2.27	70HB	C543
C545	A	61.77*	56.77	24.80	61.01*	55.32	24.72	-.15	-.45	-.13	2.22	70SA	C545
C549	A	65.08	59.61	25.83	64.68	59.09	25.68	-.20	-.52	-.15	2.36	70DB	C549
C552	A	64.21	58.24	25.21	63.82	57.55	25.04	-.39	-.69	-.17	2.41	70BN	C552
C608	A	64.32	57.88	26.72	64.04	57.30	26.61	-.28	-.59	-.11	2.34	70GC	C608
C613	A	65.34	60.07	24.80	65.25	59.65	24.35	-.08	-.41	-.20	2.44	70MD	C613
C627	A	64.23	58.66	26.01	63.98	58.15	25.96	-.25	-.51	-.05	1.95	70SA	C627
C630	A	64.38	58.60	25.75	64.03	58.00	25.69	-.35	-.60	-.06	1.94	70KS	C630
C631	A	65.00	59.15	25.39	64.75	58.60	25.56	-.25	-.55	.17 *	2.08	70AC	C631
C632	A	64.92	59.14	25.81	64.36	58.36	25.37	-.56 X	-.78 *	-.14	1.97	70AC	C632
C638	A	63.80	57.30	25.30	63.55	56.80	25.30	-.25	-.50	-.20	2.06	70GC	C638
C644	A	64.08	58.42	25.66	63.66	57.69	24.98	-.41	-.72	-.37	2.70	70MD	C644
C645	A	63.51	56.43*	24.64	63.27	55.91*	24.55	-.24	-.52	-.29	2.43	70AC	C645
C656	#	63.97	58.12	25.42	63.67	57.53	25.20	-.30	-.60	-.22	2.37	70SA	C656
C657	A	63.18	58.50	23.76*	63.05	58.00	23.48*	-.13	-.50	-.28	2.86	70AC	C657
C660	A	62.49	56.48*	23.41*	62.28	55.98*	23.20*	-.22	-.50	-.21	2.32	70AC	C660
C662	•	62.88	58.04	23.71*	62.62	57.48	23.56*	-.25	-.56	-.15	2.32	70SP	C662
C672	A	65.25	59.15	26.80	65.00	58.55	26.50	-.25	-.60	-.30	2.78	70GC	C672
C675	A	65.03	59.19	25.79	64.72	58.55	25.43	-.31	-.65	-.37	2.79	70AC	C675

X, Y, Z SPACE ANALYSIS, NORMAL DATA

COLOR • COLOR DIFFERENCE

FOR PAINT CHIPS

LAB CODE	F	SAMPLE D13 MEAN X	MEAN Y	MEAN Z	SAMPLE D14 MEAN X	MEAN Y	MEAN Z	DIFFERENCE D14 - D13 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C700	@	63.97	58.38	25.40	63.82	57.91	25.26	-.15	-.46	-.14	2.33	70DH	C700
C707	@	50.01X	45.28X	20.41X	49.82X	44.70X	20.25X	-.39	-.59	-.16	2.03	70SA	C707
C716	#	63.68	57.85	25.34	63.44	57.40	25.28	-.24	-.45	-.06	1.61	70ZE	C716
C717A	•	63.16	58.56	23.66	62.87	57.94	23.64	-.30	-.62	-.22	2.52	70SP	C717A
C717B	•	63.35	58.76	23.97	63.09	58.19	23.80	-.26	-.57	-.17	2.35	70SP	C717B
C718A	@	63.09	59.49	23.46*	63.16	58.24	23.46*	.07 *	-.25 *	.00	2.09	70AC	C718A
C718B	@	63.06	58.39	23.52*	63.07	58.04	23.47*	.01 *	-.35	-.06	2.44	70SA	C718B
C719C	@	62.14*	56.96	25.00	61.92*	56.42	24.89	-.22	-.55	-.12	2.47	70KC	C719C
C720A	•	63.17	58.47	23.88	62.98	57.99	23.88	-.19	-.48	.00	2.03	70SP	C720A
C720B	•	63.09	58.40	23.84	62.88	57.89	23.87	-.22	-.51	.03	2.06	70SP	C720B
C721	#	63.79	57.30	27.55*	63.73	56.98	27.56*	-.07	-.32	-.02	1.79	70KS	C721
C722	@	64.81	58.82	25.81	64.54	58.26	25.55	-.27	-.56	-.06	2.18	70AC	C722
C723	@	63.50	58.06	25.00	63.25	57.55	25.04	-.24	-.51	-.03	1.94	70MD	C723
C724	@	64.38	58.95	25.76	64.20	58.47	25.61	-.18	-.49	-.14	2.26	70SA	C724
C726	@	65.92	60.72	27.00	65.53	60.00	26.55	-.40	-.72	-.48 *	2.87	70SA	C726
C727A	•	63.14	58.54	23.94	62.87	57.96	23.73	-.27	-.58	-.21	2.41	70SP	C727A
C727B	•	63.32	59.05	24.11	62.99	58.38	23.76	-.32	-.67	-.35	2.77	70SP	C727B
C741	@	64.39	58.42	25.70	64.25	57.96	25.63	-.14	-.46	-.07	2.28	70SA	C741
GRAND MEANS		64.36	58.69	25.55	64.13	58.16	25.40	-.22	-.53	-.15	2.34		
SD OF MEANS		.97	1.01	.07	.96	1.02	.87	.10	.11	.12	.38		
INCLUDED LABS FOR THIS MEAN		67	67	66	67	67	66	67	68	68	68		

X, Y, Z SPACE ANALYSIS, NORMAL DATA

COLOR • COLOR DIFFERENCE

FOR PAINT CHIPS

LAB CODE	F	SAMPLE D15 MEAN X	MEAN Y	MEAN Z	SAMPLE D16 MEAN X	MEAN Y	MEAN Z	DIFFERENCE D16 - D15 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C157	G	8.93	12.02	13.73	8.88	11.91	13.08	-.25 *	-.11 *	-.70 *	2.44	70GE	C157
C162	G	9.27	12.15	14.10	9.15	12.16	13.47	-.12	.01	-.63	2.27	70DC	C162
C251	G	8.92	11.80	13.11	8.92	12.00	12.64	.00	.20	-.47	2.70	70SA	C251
C253	G	8.83	11.68	12.76	8.69	11.65	12.12	-.15	-.03	-.64	2.32	70GC	C253
C278	G	9.40	12.10	14.35*	9.40	12.25	13.95*	.00	.15	-.40	2.07	70NE	C278
C407	G	9.40	12.30	13.71	9.34	12.35	13.12	-.06	.05	-.59	2.33	70BL	C407
C414	G	8.73	11.66	12.75	8.83	11.89	12.42	.10	.23	-.34	2.44	70MD	C414
C416A	G	8.81	11.79	12.47	8.79	11.90	11.98	-.02	.11	-.49	2.35	70IB	C416A
C416B	G	8.83	11.87	13.00	8.77	11.93	12.45	-.06	.06	-.55	2.31	70GE	C416B
C418	G	9.05	12.00	14.71*	9.18	12.28	14.40*	.13	.28	-.32	2.51	70CE	C418
C422	G	8.67	11.51	12.55	8.73	11.66	11.92	.06	.15	-.43	2.53	70SA	C422
C424	G	9.11	12.05	13.55	9.18	12.23	13.18	.06	.18	-.40	2.35	70CA	C424
C428	G	8.71	11.69	12.97	8.84	11.94	12.35	.13	.25	-.32	2.59	70HB	C428
C437	G	8.89	11.80	12.71	8.88	11.91	12.22	-.01	.11	-.49	2.32	70GC	C437
C443	G	9.29	12.18	13.74	9.27	12.29	13.19	-.02	.12	-.51	2.36	70CL	C443
C444	G	9.01	11.97	13.34	9.06	12.14	12.90	.05	.17	-.44	2.45	70GE	C444
C446	G	8.96	11.90	13.04	9.11	12.17	12.77	.15	.27	-.28	2.48	70GE	C446
C451	G	8.99	11.88	13.12	9.09	12.10	12.85	.10	.22	-.34	2.38	70AC	C451
C459	G	8.69	11.59	12.87	8.83	11.84	12.58	.14	.25	-.28	2.45	70GE	C459
C460	G	8.46	11.38	12.66	8.70	11.73	12.53	.24	.35	-.15	2.75	70GE	C460
C462A	G	8.65	11.60	12.80	8.75	11.80	12.20	.10	.20	-.40	2.70	70BB	C462A
C463	G	8.98	11.95	13.45	9.15	12.24	13.13	.16	.29	-.29	2.68	70ZD	C463
C469	G	9.24	12.17	13.65	9.10	12.16	13.12	-.14	-.01	-.56	2.06	70GE	C469
C470	G	9.08	12.04	13.76	9.02	12.11	13.26	-.05	.07	-.50	2.11	70DH	C470
C472	G	9.12	12.06	13.89	9.14	12.21	13.29	.02	.15	-.40	2.14	70ZD	C472
C473	G	8.87	11.72	13.04	8.86	11.85	12.91	-.00	.13	-.43	2.13	70DH	C473
C474	G	9.09	12.00	13.29	9.00	12.04	12.76	-.09	.04	-.53	2.12	70SA	C474
C476	G	9.04	11.98	13.40	8.87	11.92	12.74	-.17 *	-.06 *	-.67 *	2.21	70SA	C476
C480	G	8.45	11.37	12.44	8.59	11.64	12.16	.14	.27	-.28	2.53	70BB	C480
C481	G	8.85	11.75	12.75	8.95	12.05	12.40	.10	.30	-.35	2.75	70BB	C481
C482	G	8.42	11.24*	12.09	8.45	11.40*	11.69	.03	.16	-.40	2.33	70GC	C482
C483	G	8.91	11.90	13.05	8.92	12.10	12.64	.01	.20	-.41	2.50	70SL	C483
C495	G	9.01	11.93	13.09	9.28	12.32	13.48	.27	.38	-.10	2.75	70KS	C495
C496A	G	9.19	12.18	13.83	9.38	12.49	13.31	.19	.31	-.22	2.54	70GE	C496A
C499C	X	9.56*	12.68*	13.82	9.29	12.56	12.65	-.27 *	-.12 *	-.97 X	3.17X	70BL	C499C
C508	G	8.67	11.62	12.90	8.72	11.80	12.58	.05	.18	-.38	2.27	70GE	C508
C511	G	8.88	11.81	13.18	8.90	11.96	12.77	.02	.14	-.41	2.19	70DH	C511
C512	G	8.69	11.54	13.03	8.85	11.83	12.81	.16	.29	-.22	2.35	70AC	C512
C514B	G	8.57	11.91	12.18	8.78	12.23	11.98	.20	.32	-.20	2.57	70SP	C514B
C524	G	9.27	12.21	13.84	9.36	12.43	13.33	.10	.22	-.30	2.17	70GE	C524
C526	G	9.00	11.91	13.65	9.03	12.07	13.20	.02	.16	-.39	2.15	70KS	C526
C528	G	8.77	11.70	12.96	8.75	11.80	12.50	-.02	.11	-.46	2.18	70MD	C528
C529	G	8.56	11.73	12.63	8.54	11.84	11.80	-.01	.11	-.42	2.12	70DH	C529
C534	G	8.81	11.67	12.93	8.84	11.86	12.61	.04	.19	-.32	2.10	70MD	C534
C536	G	8.79	11.98	11.77	8.80	12.10	11.39*	.01	.12	-.38	2.05	70AC	C536
C540	G	9.59*	12.61*	13.81	9.55*	12.63*	13.30	-.04	.07	-.51	2.15	70GE	C540
C543	G	8.76	11.73	12.73	8.87	11.98	12.40	.11	.25	-.33	2.47	70HB	C543
C545	G	8.48	11.31	12.79	8.56	11.51*	12.44	.08	.20	-.35	2.38	70SA	C545
C549	G	8.88	11.78	13.05	8.76	11.78	12.75	-.13	.00	-.58	2.17	70DH	C549
C552	G	8.51	11.43	12.29	8.52	11.56	11.83	.01	.13	-.45	2.39	70BN	C552
C608	G	9.69*	12.66*	13.81	9.77X	12.86X	13.26	.08	.21	-.35	2.21	70GC	C608
C613	G	8.04X	11.57	11.93*	8.23*	11.88	11.14*	.18	.31	-.24	2.74	70MD	C613
C627	G	8.94	11.92	13.62	9.12	12.22	12.96	.18	.30	-.26	2.65	70SA	C627
C630	G	8.99	11.95	13.55	9.25	12.32	13.22	.26	.38	-.14	2.83	70KS	C630
C631	G	9.00	11.90	13.24	9.15	12.16	12.97	.15	.26	-.27	2.51	70AC	C631
C632	G	8.99	11.86	13.25	9.15	12.13	13.00	.16	.27	-.25	2.44	70AC	C632
C638	G	8.50	11.50	12.40	8.65	11.70	12.05	.15	.20	-.35	3.01*	70GC	C638
C644	G	8.69	11.56	12.62	8.78	11.78	12.27	.10	.22	-.35	2.42	70MD	C644
C645	G	9.14	12.04	12.89	9.24	12.23	12.34	.10	.19	-.35	2.37	70AC	C645
C656	G	8.96	11.90	13.02	9.06	12.11	12.69	.10	.21	-.34	2.36	70SA	C656
C657	G	8.71	11.96	12.20	8.85	12.21	11.98	.13	.25	-.29	2.49	70AC	C657
C660	G	9.09	12.33	12.41	9.17	12.49	11.73	.08	.16	-.38	2.41	70AC	C660
C662	G	8.57	11.77	12.15	8.70	12.01	11.84	.13	.24	-.31	2.51	70SP	C662
C672	G	8.60	11.35	12.30	8.75	11.60	12.00	.15	.25	-.30	2.66	70GC	C672
C675	G	9.14	12.04	13.97	9.14	12.16	12.90	.00	.12	-.46	2.26	70AC	C675

X, Y, Z SPACE ANALYSIS, NORMAL DATA

COLOR • COLOR DIFFERENCE

FOR PAINT CHIPS

LAB CODE	F	SAMPLE D15 MEAN X	MEAN Y	MEAN Z	SAMPLE D16 MEAN X	MEAN Y	MEAN Z	DIFFERENCE D16 - D15 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C700	G	8.69	11.61	12.71	8.95	11.97	12.77	.26	.37	-.14	2.8C	70DH	C700
C707	G	7.92X	10.06X	11.49*	8.07X	10.30X	11.38*	.15	.24	-.11	1.88*	70SA	C707
C716	#	13.78X	11.90	13.55	9.37	12.15	12.99	-4.41 X	.25	-.36	83.40X	70ZE	C716
C717A	•	8.83	12.01	12.94	8.90	12.19	12.21	.07	.18	-.33	2.16	70SP	C717A
C717B	•	8.72	11.90	12.49	8.88	12.19	12.26	.16	.29	-.23	2.41	70SP	C717B
C718A	G	8.64	11.87	12.17	8.74	12.08	11.85	.10	.22	-.31	2.33	70AC	C718A
C718B	G	8.65	11.86	12.21	8.89	12.24	12.08	.24	.38	-.13	2.59	70SA	C718B
C719C	G	8.94	11.84	13.24	9.09	12.12	12.97	.15	.27	-.27	2.44	70KC	C719C
C720A	•	8.67	11.86	12.33	8.79	12.10	12.03	.12	.24	-.30	2.41	70SP	C720A
C720B	•	8.62	11.82	12.29	8.77	12.08	12.02	.14	.26	-.26	2.45	70SP	C720B
C721	#	10.12X	13.16X	13.92	10.30X	13.44X	13.65	.19	.28	-.28	2.58	70KS	C721
C722	G	9.05	11.94	13.26	9.16	12.17	12.92	.11	.23	-.34	2.45	7CAC	C722
C723	G	8.52	11.39	12.00	8.74	11.74	12.52	.22	.35	-.16	2.63	70MD	C723
C724	G	8.87	11.82	13.11	9.08	12.14	12.89	.21	.32	-.22	2.68	70SA	C724
C726	G	9.14	12.05	13.75	9.31	12.37	13.54	.17	.32	-.24	2.50	70SA	C726
C727A	•	8.62	11.83	12.92	8.72	12.04	12.00	.10	.22	-.32	2.35	70SP	C727A
C727B	•	8.59	11.73	12.48	8.62	11.89	12.08	.03	.15	-.38	2.17	70SP	C727B
C741	G	9.00	11.97	13.34	9.03	12.09	12.93	.02	.12	-.41	2.10	70SA	C741
GRAND MEANS		8.92	11.86	13.04	8.90	12.03	12.67	.07	.19	-.37	2.40		
SD OF MEANS		.27	.28	.04	.26	.26	.62	.11	.11	.14	.23		
INCLUDED LABS FOR THIS MEAN		66	67	68	66	66	68	68	68	68	68		

MCCA COLLABORATIVE REFERENCE PROGRAM
L, a, b SPACE ANALYSIS, NORMAL DATA
COLOR • COLOR DIFFERENCE
FOR PAINT CHIPS

LAB CODE	F	SAMPLE D13 MEAN L	MEAN A	MEAN B	SAMPLE D14 MEAN L	MEAN A	MEAN B	DIFFERENCE D14 - D13 ΔL	ΔA	ΔB	ΔE	INST CODE	LAB
C121	6	76.25	16.55	34.45	75.95	17.50	34.25	-.30	.95 *	-.20	1.02	70HM	C121
C148	6	76.70	16.95	33.70	76.35	17.80	33.60	-.35	.85	-.10 *	.92	70HF	C148
C152	6	77.20	16.90	33.60	76.80	17.70	33.60	-.40	.80	-.20	.92	70HA	C152
C166	6	76.95	16.55	33.70	76.60	17.30	33.40	-.35	.75	-.30	.88	70HA	C166
C183	6	76.95	16.10	33.60	76.45	17.00	33.40	-.50 *	.90	-.20	1.05	70HA	C183
C223	6	76.49	17.01	33.58	76.12	17.79	33.14	-.37	.78	-.24	.89	70HA	C223
C241	6	77.40	15.90	34.00	76.90	16.85	33.60	-.50 *	.95 *	-.20	1.09*	70HF	C241
C256A	6	76.70	16.33	33.90	76.32	17.15	33.79	-.38	.82	-.18	.92	70HM	C256A
C256B	6	76.76	16.02	34.15	76.41	16.78	33.94	-.35	.75	-.21	.86	70HU	C256B
C288	6	76.50	16.70	34.00	76.10	17.50	33.70	-.40	.80	-.30	.94	70SC	C288
C291	6	76.85	16.60	33.80	76.50	17.35	33.40	-.35	.75	-.20	.85	70HA	C291
C317	6	76.20	16.70	33.70	75.90	17.50	33.50	-.30	.80	-.20	.88	70HM	C317
C325	6	76.09	15.46	32.95	75.80	16.25	32.67	-.30	.79	-.27	.88	70HF	C325
C356	6	76.60	16.80	33.50	76.30	17.50	33.70	-.30	.70	-.20	.79	70HM	C356
C380	6	77.30	16.80	34.20	76.90	17.55	34.00	-.40	.75	-.20	.87	70HA	C380
C382	6	76.90	15.60	33.70	76.50	16.40	33.50	-.40	.80	-.20	.92	70HA	C382
C390	6	76.70	18.45	33.75	76.30	19.35*	33.60	-.40	.90	-.15	1.00	70HF	C390
C420A	6	76.40	17.60	34.20	76.05	18.40	34.00	-.35	.80	-.20	.90	70HF	C420A
C420B	6	76.65	17.70	34.30	76.05	18.40	34.00	-.60 X	.70	-.30	.97	70HF	C420B
C427	6	76.95	17.20	34.00	76.60	17.95	33.70	-.35	.75	-.30	.88	70HA	C427
C440	6	76.78	17.78	34.39	76.56	18.50	34.07	-.22 *	.72	-.33	.82	70HA	C440
C442	6	76.90	15.70	33.60	76.55	16.50	33.60	-.35	.80	-.20	.90	70HM	C442
C454	6	76.00	15.80	33.00	75.56	16.70	32.81	-.44	.90	-.19	1.02	70HA	C454
C458	6	76.83	16.57	33.81	76.49	17.35	33.40	-.34	.78	-.21	.88	70HM	C458
C475	6	76.59	16.98	33.97	76.20	17.87	33.37	-.40	.88	-.20	.99	70HA	C475
C477	6	76.35	17.87	33.20	75.99	18.63	33.02	-.36	.76	-.24	.87	70HA	C477
C494	6	77.45	16.95	33.80	77.15	17.60	33.45	-.30	.65	-.15	.73*	70HA	C494
C496B	6	76.70	15.67	37.07X	76.47	16.40	37.48X	-.23	.73	-.19	.79	70GP	C496B
C499A	6	76.70	17.20	30.10X	76.45	17.90	29.80X	-.25	.70	-.30	.80	70HA	C499A
C499B	6	76.70	17.00	33.80	76.25	17.60	33.30	-.45	.80	-.30	.97	70HA	C499B
C506	6	77.05	17.10	33.70	76.75	17.85	33.50	-.30	.75	-.20	.83	70HF	C506
C514A	•	76.42	17.14	33.79	76.15	17.89	33.46	-.28	.75	-.24	.83	70SR	C514A
C517	6	77.30	16.00	34.05	77.00	16.60	33.60	-.30	.80	-.20	.88	70SC	C517
C538	6	77.80*	16.50	32.75*	77.45*	17.20	32.50*	-.35	.70	-.25	.82	70GX	C538
C541	6	76.70	17.60	33.85	76.35	18.40	33.00	-.35	.80	-.25	.91	70GP	C541
C543	6	77.03	15.55	33.53	76.73	16.33	33.30	-.30	.78	-.23	.87	70HA	C543
C546A	6	75.90	18.30	33.70	75.60	19.10	33.40	-.30	.80	-.30	.91	70HQ	C546A
C546B	6	76.10	16.80	33.30	75.70	17.55	33.50	-.40	.75	-.30	.90	70HM	C546B
C547	6	75.64*	17.88	34.41	75.35*	18.76	34.12	-.29	.88	-.30	.97	70HQ	C547
C574	6	77.40	15.35	32.70*	77.00	16.05	32.40*	-.40	.70	-.30	.86	70HQ	C574
C600	6	76.30	19.10*	33.05	76.00	20.00*	32.85	-.30	.90	-.20	.97	70GD	C600
C620	6	74.65X	15.70	33.50	74.32X	16.38	33.27	-.33	.68	-.23	.79	70MG	C620
C628	6	77.60	15.41	33.69	77.19	16.09	33.75	-.41	.67	-.24	.83	70ME	C628
C633	6	77.13	17.58	33.54	76.78	18.24	32.99	-.35	.66	-.35 *	.82	70HA	C633
C655	6	76.96	16.15	34.15	76.59	16.97	34.01	-.38	.82	-.14	.91	70HU	C655
C677	6	76.98	17.15	33.93	76.32	17.97	33.80	-.66 X	.81	-.13	1.05*	70SC	C677
C690	6	76.60	16.60	33.80	76.25	17.30	33.40	-.35	.70	-.20	.81	70HA	C690
C705	X	59.31X	65.44X	23.80X	58.80X	65.24X	25.64X	-.51 *	-.19 X	-.16	.57X	70SC	C705
C709	6	76.43	16.16	33.82	76.10	16.88	33.53	-.33	.71	-.30	.84	70SC	C709
C719A	6	77.05	15.00	34.00	76.05	15.70*	33.70	-.40	.70	-.30	.86	70HA	C719A
C719B	6	76.85	17.45	33.80	76.60	18.15	33.60	-.25	.70	-.20	.77	70HA	C719B
C742	•	81.20X	22.55X	37.04X	81.02X	23.36X	37.04X	-.19 *	.82	-.00 X	.84	70SR	C742
GRAND MEANS		76.75	16.74	33.75	76.39	17.51	33.50	-.35	.78	-.23	.89		
SD OF MEANS		.45	.88	.41	.44	.89	.42	.06	.08	.06	.08		
INCLUDED LABS FOR THIS MEAN		47	48	46	47	48	46	46	48	48	48		

L, a, b SPACE ANALYSIS, NORMAL DATA

COLOR • COLOR DIFFERENCE

FOR PAINT CHIPS

LAB CODE	F	SAMPLE D15 MEAN L	MEAN A	MEAN B	SAMPLE D16 MEAN L	MEAN A	MEAN B	DIFFERENCE D16 - D15 ΔL	ΔA	ΔB	ΔE	INST CODE	LAB
C121	6	33.80	-14.40	2.10	34.10	-14.90	3.20	.30	-.50	1.10	1.24	70HM	C121
C148	6	34.55	-14.55	2.20	34.90	-14.95	3.20	.35	-.40	1.00	1.13	70HF	C148
C152	6	34.60	-14.00	1.95	34.45	-14.60	3.00	-.15 X	-.60	1.05	1.22	70HA	C152
C166	6	34.30	-14.15	1.80	34.30	-14.75	2.90	.00 *	-.60	1.10	1.25	70HA	C166
C183	6	34.35	-15.45X	3.10X	34.15	-14.85	2.10	-.20 X	.60 X	-1.00 X	1.18	70HA	C183
C223	6	34.97	-14.43	2.02	35.18	-14.99	3.14	.21	-.56	1.11	1.26	70HA	C223
C241	6	34.30	-13.90	1.90	34.35	-14.45	3.00	.05	-.55	1.10	1.23	70HF	C241
C256A	6	33.89	-14.10	1.80	34.13	-14.57	2.91	.24	-.46	1.11	1.23	70HM	C256A
C256B	6	33.76	-13.58	.00*	34.02	-14.03	1.71*	.26	-.45	1.05	1.17	70HU	C256B
C288	6	34.00	-13.80	1.90	34.20	-14.40	2.90	.20	-.60	1.00	1.18	70SC	C288
C291	6	34.50	-14.05	2.20	34.70	-14.55	3.30	.20	-.50	1.10	1.22	70HA	C291
C317	6	33.90	-14.00	2.10	34.30	-14.40	3.20	.40	-.40	1.10	1.24	70HM	C317
C325	6	34.42	-14.35	1.81	34.71	-15.16	2.80	.29	-.81 X	.99	1.31*	70HR	C325
C356	6	33.80	-13.60	2.10	34.10	-14.00	3.20	.30	-.40	1.10	1.21	70HM	C356
C380	6	34.25	-14.00	2.10	34.60	-14.50	3.20	.35	-.50	1.10	1.26	70HA	C380
C382	6	34.40	-14.25	1.90	34.60	-14.85	3.00	.20	-.60	1.10	1.27	70HA	C382
C390	6	34.55	-14.05	1.85	34.80	-14.45	2.90	.25	-.40	1.05	1.15	70HF	C390
C420A	6	34.20	-16.75X	1.10	34.70	-17.10X	2.10	.50	-.35	1.00	1.17	70HF	C420A
C420B	6	34.25	-16.75X	1.10	34.65	-17.05X	2.10	.40	-.30 *	1.00	1.12	70HF	C420B
C427	6	34.40	-13.90	2.20	34.60	-14.40	3.20	.20	-.50	1.00	1.14	70HA	C427
C440	6	34.35	-14.39	2.20	34.72	-14.87	3.28	.37	-.48	1.01	1.18	70HA	C440
C442	6	33.95	-13.70	1.80	34.10	-14.20	2.30	.15	-.50	1.00	1.13	70HM	C442
C454	6	35.02	-14.22	1.75	35.27	-14.86	2.82	.25	-.64	1.09	1.25	70HA	C454
C458	6	33.87	-13.93	1.85	34.10	-14.46	2.37	.24	-.53	1.02	1.17	70HM	C458
C475	6	34.56	-14.02	.98	34.77	-14.59	1.98	.21	-.57	1.00	1.17	70HA	C475
C477	6	34.78	-14.36	1.90	35.05	-14.94	2.54	.27	-.58	.98	1.17	70HA	C477
C494	6	34.70	-14.40	1.80	35.00	-14.90	2.30	.30	-.50	1.10	1.24	70HA	C494
C496B	6	34.02	-14.83*	4.02X	34.25	-15.37	5.03X	.22	-.54	1.02	1.17	70GP	C496B
C499A	6	33.95	-14.45	-7.30X	34.40	-14.85	-6.25X	.45	-.40	1.05	1.21	70HA	C499A
C499B	6	34.35	-14.15	2.10	34.65	-14.60	3.10	.30	-.45	1.00	1.14	70HA	C499B
C506	6	34.15	-14.20	2.10	34.70	-14.55	3.10	.55 *	-.35	1.00	1.19	70HF	C506
C514A	•	34.28	-14.11	1.98	34.66	-14.49	2.07	.38	-.38	1.00	1.14	70SR	C514A
C517	6	34.50	-12.95X	.90	34.60	-13.60*	1.90	.10	-.65	1.00	1.20	70SC	C517
C538	6	35.20*	-10.70X	-1.30X	35.40*	-11.20X	-.30X	.20	-.50	1.00	1.14	70GX	C538
C541	6	34.10	-13.60	1.80	34.40	-14.00	2.30	.30	-.40	1.00	1.12	70GP	C541
C543	6	34.29	-14.11	1.92	34.61	-14.63	2.95	.32	-.51	1.02	1.19	70HA	C543
C546A	6	33.70	-14.10	1.80	34.05	-14.60	2.30	.35	-.50	1.00	1.17	70HQ	C546A
C546B	6	33.55	-14.00	2.00	33.90	-14.60	3.05	.35	-.60	1.05	1.26	70HM	C546B
C547	6	32.15X	-15.01*	1.94	32.21X	-15.75*	2.40	.06	-.75 *	1.06	1.30	70HQ	C547
C574	6	38.20X	-11.70X	1.20	38.50X	-12.15X	2.10	.30	-.45	.90 *	1.05*	70HQ	C574
C600	6	34.70	-14.50	2.10	34.95	-15.00	3.10	.25	-.50	1.00	1.15	70GD	C600
C620	6	32.71X	-13.94	1.87	33.07X	-14.40	2.53	.36	-.46	.96	1.13	70MG	C620
C628	6	34.74	-14.47	1.93	35.28	-14.84	2.51	.54 *	-.37	.96	1.16	70ME	C628
C633	6	34.52	-14.13	2.03	34.86	-14.56	3.09	.34	-.43	1.06	1.19	70HA	C633
C655	6	34.50	-13.61	1.85	34.85	-14.10	2.25	.15	-.49	1.01	1.13	70HU	C655
C677	6	34.93	-12.97X	.90	34.90	-13.51*	2.03	-.03 *	-.54	1.07	1.20	70SC	C677
C690	6	33.70	-14.00	2.00	33.90	-14.60	3.10	.20	-.60	1.10	1.27	70HA	C690
C705	X	11.71X	8.72X	12.53X	12.04X	8.92X	12.29X	.33	.20 X	-.24 X	.46X	70SC	C705
C709	6	35.04	-14.17	1.83	35.47*	-14.57	2.53	.43	-.40	1.00	1.16	70SC	C709
C719A	6	34.50	-14.20	1.90	34.85	-14.80	2.05	.35	-.60	1.05	1.26	70HA	C719A
C719B	6	34.10	-14.30	1.80	34.55	-14.70	2.80	.45	-.40	1.00	1.17	70HA	C719B
C742	•	32.56X	-13.22*	-2.70X	32.50X	-13.50*	-1.68X	-.06 *	-.27 *	1.02	1.05*	70SR	C742
GRAND MEANS		34.33	-14.14	1.88	34.58	-14.61	2.69	.28	-.50	1.04	1.19		
SD OF MEANS		.40	.32	.44	.40	.41	.46	.13	.09	.05	.06		
INCLUDED LABS FOR THIS MEAN		45	41	44	45	44	45	46	46	47	48		

EXPLANATION OF DATA FOR WHITE SAMPLE FOR PAINT CHIPS

Specimens of a white calibration sample (Paint Chips) were distributed to the participants along with the usual two pairs of colored specimens, and each participant was asked to return measurement data for the white calibration sample (Paint Chips), reporting results in the same manner as for the colored specimens.

As a first step, three laboratories were selected to serve as "reference" laboratories for the purposes of this analysis and the average of their X, Y, Z values for the white sample were computed. Next, the ratios of the participants data to the combined reference laboratory values were calculated for each participant (transformed to X, Y, Z space if necessary). These ratios are shown in the White Sample Analysis tables.

Two observations can be made about the data in the White Sample Analysis tables. First, the participants as a whole tend to be high compared with the combined average values obtained by the selected reference laboratories. Second, a few participants had noticeably extreme values for one or more of the components and these participants especially should look to the cause.

Next, the ratios in the White Sample Analysis tables were used to "adjust" the data of the normal data tables to obtain the adjusted data table values. The adjustment consisted of dividing the X, Y, Z values of the normal data tables by the respective ratios in the White Sample Analysis tables.

The significant change is the adjusted data tables is in the SD OF MEANS. Comparison of these among-laboratory standard deviations with those in the normal data tables, shows considerable reduction for X, Y, Z. Thus part, at least, of the disagreement among participants is due to errors in standardization that could be corrected through use of an agreed-upon white standard. There is no similar significant change for ΔX, ΔY, and ΔZ.

WHITE SAMPLE ANALYSIS FOR PAINT CHIPS

X, Y, Z LABORATORIES

LAB CODE	RATIO--(LAB/COMBINED) X	Y	Z	INST CODE	PERCENT FROM COMBINED X	Y	Z
C157	1.0182	1.0166	1.0251	70GB	1.82	1.66	2.51
C162	1.0145	1.0111	1.0192	70DC	1.45	1.11	1.92
C251	1.0027	.9983	1.0028	70SA	.27	-.17	.28
C253	1.0132	1.0099	1.0131	70GC	1.32	.99	1.31
C278	1.0337	1.0331	1.0338	70NB	3.37	3.31	3.38
C407	1.0116	1.0095	1.0176	70BL	1.16	.95	1.76
C414	.9890	.9891	.9827	70MD	-1.10	-1.09	-1.73
C416A	1.0485	1.0471	1.0237	70AB	4.85	4.71	2.37
C416B	1.0231	1.0221	1.0235	70GB	2.31	2.21	2.35
C418	.9826	.9790	1.0911	70GB	-1.74	-2.10	9.11
C422	.9895	.9868	.9862	70SA	-1.05	-1.32	-1.38
C424	.9905	.9906	.9975	70CA	-.95	-.94	-.25
C428	1.0081	1.0054	1.0118	70MB	.61	.54	1.18
C437	.9973	.9959	.9926	70GC	-.27	-.41	-.74
C443	1.0148	1.0100	1.0266	70GL	1.48	1.00	2.66
C444	1.0113	1.0119	1.0189	70GB	1.13	1.19	1.89
C446	1.0013	1.0007	1.0055	70GB	.13	.07	.55
C451	1.0129	1.0130	1.0087	70AC	1.29	1.30	.87
C459	.9987	.9993	.9945	70GB	-.13	-.07	-.55
C460	1.0075	1.0081	1.0087	70GB	.75	.81	.87
C462A	1.0014	.9988	1.0096	70AB	.14	-.12	.96
C463	1.0098	1.0082	1.0171	70ZD	.98	.82	1.71
C469	.9631	.9616	.9511	70GB	-3.69	-3.84	-4.89
C470	1.0353	1.0349	1.0521	70DH	3.53	3.49	5.21
C472	.9953	.9931	.9987	70ZD	-.47	-.69	-.13
C473	1.0095	1.0074	1.0097	70DA	.95	.74	.97
C474	.9911	1.0027	1.0081	70SA	-.89	.27	.81
C476	1.0013	.9994	1.0047	70SA	.13	-.06	.47
C480	1.0082	1.0048	1.0164	70AB	.82	.48	1.64
C481	1.0037	1.0010	1.0067	70AB	.37	.10	.67
C482	.9915	.9895	.9876	70GC	-.85	-1.05	-1.24
C483	.9984	.9961	1.0034	70SL	-.16	-.39	.34
C495	1.0120	1.0117	1.0100	70AS	1.20	1.17	1.00
C496A	1.0219	1.0219	1.0257	70GB	2.19	2.19	2.57
C496C	1.0254	1.0255	1.0391	70BL	2.54	2.55	3.91
C508	1.0086	1.0068	1.0114	70GB	.86	.68	1.14
C511	1.0064	1.0055	1.0067	70DB	.64	.55	.67
C512	1.0153	1.0152	1.0032	70AC	1.53	1.52	.32
C514B	.9868	1.0186	.9413	70SP	-1.32	1.86	-5.87
C524	1.0180	1.0168	1.0209	70GB	1.80	1.68	2.09
C526	1.0118	1.0100	1.0131	70AS	1.18	1.00	1.31
C528	.9891	.9893	.9812	70MD	-1.09	-1.07	-1.88
C529	.9676	.9904	.9225	70DA	-3.24	-.96	-7.75
C534	.9798	.9838	.9837	70MD	-2.02	-1.62	-1.63
C536	.9756	1.0071	.9086	70AC	-2.44	.71	-9.14
C540	1.0174	1.0176	1.0215	70GB	1.74	1.76	2.15
C543	1.0067	1.0040	1.0141	70AB	.67	.40	1.41
C545	.9749	.9759	.9812	70SA	-2.51	-2.41	-1.88
C549	1.0119	1.0068	1.0145	70DB	1.19	.68	1.45
C552	.9936	.9910	1.0033	70BN	-.64	-.90	.33
C608	.9939	.9912	.9928	70GC	-.61	-.88	-.72
C613	1.0244	1.0237	1.0203	70MD	2.44	2.37	2.03
C627	.9978	.9962	.9976	70SA	-.22	-.38	-.24
C630	1.0079	1.0053	1.0149	70AS	.79	.53	1.45
C631	1.0174	1.0156	1.0130	70AC	1.74	1.56	1.30
C632	1.0119	1.0100	1.0090	70AC	1.19	1.00	.90
C638	.9958	.9938	.9960	70GC	-.42	-.62	-.40
C644	.9996	1.0004	.9931	70MD	-.04	.04	-.69
C645	1.0035	1.0093	.9867	70AC	.35	.93	-1.13
C656	.9951	.9938	.9908	70SA	-.49	-.62	-.92
C657	.9820	1.0121	.9306	70AC	-1.80	1.21	-6.94
C660	.9801	1.0114	.9145	70AC	-1.99	1.14	-8.55
C662	.9703	.9932	.9241	70SP	-2.97	-.68	-7.59
C672	.9895	.9889	.9849	70GC	-1.05	-1.11	-1.51
C675	1.0129	1.0113	1.0098	70AC	1.29	1.13	.98
C700	.9980	.9973	.9971	70DH	-.20	-.27	-.29
C707	.7984	.7976	.7984	70SA	-20.16	-20.24	-20.16
C716	.9988	.9949	1.0034	70ZB	-.12	-.51	.34
C717A	.9716	.9949	.9277	70SP	-2.84	-.51	-7.23
C717B	.9777	1.0012	.9343	70SP	-2.23	.12	-6.57
C718A	.9779	1.0076	.9265	70AC	-2.21	.76	-7.35
C718B	.9779	1.0068	.9264	70SA	-2.21	.68	-7.36
C719C	.9742	.9705	.9840	70AC	-2.58	-2.91	-1.60
C720A	.9720	.9954	.9264	70SP	-2.80	-.46	-7.36
C720B	.9701	.9932	.9260	70SP	-2.99	-.68	-7.40
C721	1.0100	1.0149	1.0047	70AS	1.00	1.49	.47
C722	1.0158	1.0146	1.0125	70AC	1.58	1.46	1.25
C723	.9855	.9855	.9739	70MD	-1.45	-1.45	-2.11
C724	1.0059	1.0058	1.0079	70SA	.59	.58	.79
C726	1.0130	1.0106	1.0204	70SA	1.30	1.06	2.04
C727A	.9388	.9583	.8797	70SP	-6.12	-4.17	-12.03
C727B	.9743	.9979	.9260	70SP	-2.57	-.21	-7.20
C741	1.0089	1.0072	1.0095	70SA	.89	.72	.95

WHITE SAMPLE ANALYSIS FOR PAINT CHIPS
L, a, b LABORATORIES

LAB CODE	RATIO--(LAB/COMBINED) X	Y	Z	INST CODE	PERCENT FROM COMBINED X	Y	Z
C121	.9991	.9946	1.0025	70HM	-.09	-.54	.25
C148	1.0058	1.0030	1.0111	70HF	.58	.30	1.11
C152	1.0083	1.0061	1.0120	70HA	.83	.61	1.20
C166	1.0056	1.0040	1.0137	70HA	.56	.40	1.37
C183	.9617	.9582	.9463	70HA	-3.83	-4.18	-5.37
C223	1.0188	1.0153	1.0238	70HA	1.88	1.53	2.38
C241	.9613	.9572	.9483	70HF	-3.87	-4.28	-5.17
C256A	.9997	.9969	1.0057	70HM	-.03	-.31	.57
C256B	1.0120	1.0106	1.0124	70HU	1.20	1.06	1.24
C288	.9605	.9561	.9480	70SC	-3.95	-4.39	-5.20
C291	1.0046	1.0030	1.0095	70HA	.46	.30	.95
C317	.9927	.9893	1.0003	70HM	-.73	-1.07	.03
C325	1.0056	1.0038	1.0086	70HA	.56	.38	.86
C356	.9987	.9977	1.0088	70HM	-.13	-.23	.88
C380	1.0083	1.0061	1.0143	70HA	.83	.61	1.43
C382	1.0079	1.0051	1.0125	70HA	.79	.51	1.25
C390	1.0064	1.0030	1.0127	70HF	.64	.30	1.27
C420A	1.0093	1.0040	1.0106	70HF	.93	.40	1.06
C420B	1.0085	1.0051	1.0101	70HF	.85	.51	1.01
C427	1.0091	1.0051	1.0086	70HA	.91	.51	.86
C440	1.0132	1.0094	1.0133	70HA	1.32	.94	1.33
C442	.9988	.9967	1.0062	70HM	-.12	-.33	.62
C454	1.0125	1.0087	1.0207	70HA	1.25	.87	2.07
C458	1.0006	.9983	1.0092	70HM	.06	-.17	.92
C475	1.0097	1.0059	1.0172	70HA	.97	.59	1.72
C477	1.0151	1.0117	1.0156	70HA	1.51	1.17	1.56
C494	1.0228	1.0199	1.0331	70HA	2.28	1.99	3.31
C496B	1.0243	1.0232	1.0224	70GP	2.43	2.32	2.24
C499A	1.0105	1.0082	1.0180	70HA	1.05	.82	1.80
C499B	1.0068	1.0040	1.0122	70HA	.68	.40	1.22
C506	1.0091	1.0072	1.0131	70HF	.91	.72	1.31
C514A	.9963	.9944	.9962	70SA	-.37	-.56	-.38
C517	1.0351	1.0316	1.0340	70SC	3.51	3.16	3.40
C538	.9826	.9841	.9850	70GX	-1.74	-1.59	-1.44
C541	1.0238	1.0210	1.0295	70GP	2.38	2.10	2.95
C543	1.0081	1.0062	1.0157	70HA	.81	.62	1.57
C546A	1.0114	1.0082	1.0134	70HQ	1.14	.82	1.34
C546B	.9963	.9935	1.0030	70HM	-.37	-.65	.30
C547	1.0070	1.0045	1.0094	70HQ	.70	.45	.94
C574	1.0263	1.0210	1.0263	70HQ	2.63	2.10	2.63
C600	.9996	.9956	.9989	70GD	-.04	-.44	-.11
C620	.9501	.9506	.9399	70MG	-4.99	-4.94	-6.01
C628	1.0220	1.0232	1.0266	70MG	2.20	2.32	2.66
C633	1.0143	1.0110	1.0233	70HA	1.43	1.10	2.33
C655	1.0123	1.0110	1.0055	70HU	1.23	1.10	.55
C677	1.0284	1.0254	1.0346	70SC	2.84	2.54	3.46
C690	1.0016	.9988	1.0021	70HA	.16	-.12	.21
C705	1.4440	.9215	-.0086	70SC	44.40	-7.85	******
C709	1.0052	1.0045	1.0070	70SC	.52	.45	.70
C719A	1.0260	1.0231	1.0364	70HA	2.60	2.31	3.64
C719B	1.0032	.9998	1.0102	70HA	.32	-.02	1.02
C742	1.0005	.9927	.9981	70SA	.05	-.73	-.19

X, Y, Z SPACE ANALYSIS, ADJUSTED DATA

COLOR • COLOR DIFFERENCE

FOR PAINT CHIPS

LAB CODE	F	SAMPLE D13 MEAN X	MEAN Y	MEAN Z	SAMPLE D14 MEAN X	MEAN Y	MEAN Z	DIFFERENCE D14 - D13 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C157	d	63.85	58.91	25.13	63.77	58.57	25.04	-.08	-.34	-.11	1.91	70GE	C157
C162	d	65.19*	60.45*	26.01	65.03*	59.98*	25.91	-.16	-.47	-.10	2.19	70DC	C162
C251	d	64.85	58.30	25.32	64.55	57.60	24.97	-.30	-.70	-.35	3.27*	70SA	C251
C253	d	64.32	58.35	25.04	64.09	57.79	25.46	-.24	-.55	-.19	2.45	70GC	C253
C278	d	63.22	57.79	25.87	63.07	57.40	25.97	-.15	-.39	.10	1.65	70NE	C278
C407	d	64.52	59.33	25.97	64.40	58.88	25.80	-.12	-.45	-.17	2.43	70BL	C407
C414	d	64.32	58.61	25.09	64.19	58.16	25.55	-.13	-.45	-.14	2.34	70MD	C414
C416A	d	63.07*	56.87*	24.75*	62.71*	56.23*	24.52*	-.36	-.64	-.23	2.39	70IB	C416A
C416B	d	63.39	57.35	25.05	63.11	56.77	24.89	-.28	-.58	-.16	2.38	70GE	C416B
C418	d	64.21	59.95*	25.69	64.02	59.31	25.46	-.19	-.64	-.23	3.28*	70CE	C418
C422	d	63.94	57.86	25.00	63.67	57.24	25.24	-.27	-.61	-.26	2.72	70SA	C422
C424	d	64.25	59.07	26.10*	63.94	58.48	25.87	-.31	-.60	-.24	2.29	70CA	C424
C428	d	64.48	58.76	25.40	64.39	58.34	25.31	-.09	-.43	-.08	2.39	70BB	C428
C437	d	64.48	58.30	25.66	64.17	57.67	25.62	-.31	-.63	-.24	2.55	70GC	C437
C443	d	64.69	59.55	25.14	64.49	58.97	24.95	-.20	-.58	-.20	2.81	70CL	C443
C444	d	63.88	58.41	25.32	63.49	57.74	25.11	-.38	-.67	-.41 *	2.62	70GE	C444
C446	d	63.94	58.41	25.33	63.72	57.88	25.43	-.22	-.53	-.13	2.31	70GE	C446
C451	d	64.21	58.44	25.31	64.04	57.93	25.04	-.17	-.52	-.27	2.71	70AC	C451
C459	d	63.59	57.98	25.32	63.23	57.33	25.21	-.37	-.65	-.11	2.23	70GE	C459
C460	d	63.93	58.50	25.00	63.74	58.01	25.09	-.19	-.48	.08	2.01	70GE	C460
C462A	#	65.16*	59.02	25.21	65.06*	58.62	25.21	-.10	-.40	.00	2.06	70HB	C462A
C463	d	64.40	58.90	25.35	64.20	58.37	25.26	-.20	-.53	-.10	2.41	70ZD	C463
C469	d	67.05X	61.59X	27.36X	66.90X	60.95X	27.20X	-.16	-.63	-.19	3.34*	70GE	C469
C470	d	64.15	59.22	25.85	63.84	58.65	25.63	-.30	-.57	-.03	1.94	70DH	C470
C472	d	64.76	59.44	26.05	64.42	58.81	25.91	-.34	-.63	-.15	2.21	70ZD	C472
C473	d	64.52	59.38	25.99	64.34	58.87	25.42	-.18	-.51	-.17	2.42	70DH	C473
C474	d	64.40	58.02	25.03	64.25	57.59	25.50	-.16	-.43	-.03	1.96	70SA	C474
C476	d	64.16	58.60	25.07	63.97	58.12	25.50	-.19	-.48	-.07	2.10	70SA	C476
C480	d	63.27	57.66	17.13X	63.07	57.26	17.17X	-.19	-.40	.03	1.51*	70HB	C480
C481	d	64.66	58.99	25.23	64.41	58.49	25.18	-.25	-.50	-.10	1.89	70HB	C481
C482	d	64.16	58.15	25.00	63.91	57.57	25.32	-.25	-.58	-.18	2.50	70GC	C482
C483	d	64.71	57.73	24.93	64.35	56.97	24.72*	-.35	-.75	-.24	3.18*	70SL	C483
C495	d	64.01	58.43	25.27	63.91	58.01	25.45	-.10	-.42	-.11	2.32	70KS	C495
C496A	d	63.67	58.17	25.46	63.66	57.86	25.45	-.01 *	-.31 *	-.00	2.05	70GE	C496A
C499C	X	63.23	57.08*	25.93	62.38X	55.78X	25.41	-.85 X	-1.30 X	-.51 *	4.11X	70BL	C499C
C508	d	64.12	58.79	25.00	64.01	58.41	25.54	-.11	-.38	.04	1.80	70GE	C508
C511	d	64.07	58.57	25.04	63.93	58.13	25.44	-.14	-.44	-.09	2.16	70DH	C511
C512	#	64.33	58.73	25.36	64.16	58.29	25.37	-.17	-.44	.00	1.90	70AC	C512
C514B	•	64.38	58.20	25.69	64.07	57.59	25.58	-.31	-.61	-.12	2.28	70SP	C514B
C524	d	64.23	58.61	25.72	63.91	57.96	25.36	-.32	-.64	-.37	2.75	70GE	C524
C526	d	64.09	58.45	25.30	63.92	57.97	25.48	-.17	-.48	-.08	2.23	70KS	C526
C528	d	64.20	58.75	25.93	64.03	58.28	25.79	-.17	-.46	-.14	2.18	70ND	C528
C529	d	65.08	58.90	25.60	64.89	58.37	25.59	-.19	-.53	-.27	2.67	70DH	C529
C534	d	65.16*	59.02	25.77	64.96*	58.61	25.82	-.20	-.41	.05	1.49*	70MD	C534
C536	d	63.69	55.76X	25.42	63.39	55.22X	25.29	-.29	-.54	-.13	2.10	70AC	C536
C540	d	63.52	57.84	25.75	63.30	57.28	25.67	-.23	-.56	-.11	2.44	70GE	C540
C543	#	64.54	59.07	25.49	64.41	58.61	25.44	-.13	-.45	-.05	2.27	70HB	C543
C545	d	63.36	58.18	25.34	63.20	57.71	25.20	-.16	-.46	-.14	2.24	70SA	C545
C549	d	64.32	59.09	25.46	64.12	58.57	25.31	-.20	-.52	-.15	2.35	70DH	C549
C552	d	64.63	58.77	25.15	64.24	58.07	24.96	-.39	-.70	-.17	2.42	70HN	C552
C608	d	64.72	58.40	26.92X	64.44	57.81	26.80X	-.28	-.59	-.12	2.34	70GC	C608
C613	d	63.78	58.68	24.97X	63.70	58.27	25.87X	-.08	-.41	-.20	2.42	70MD	C613
C627	d	64.37	58.89	26.97*	64.12	58.37	26.02*	-.25	-.52	-.05	1.95	70SA	C627
C630	d	63.88	58.29	25.39	63.53	57.70	25.32	-.35	-.60	-.06	1.94	70KS	C630
C631	d	63.89	58.25	25.90	63.64	57.70	25.24	-.25	-.54	.17 *	2.06	70AC	C631
C632	d	64.16	58.55	25.29	63.61	57.78	25.15	-.55 X	-.77 *	-.14	1.96	70AC	C632
C638	d	64.07	57.66	25.00	63.82	57.15	25.40	-.25	-.50	-.20	2.07	70GC	C638
C644	d	64.11	58.40	25.33	63.69	57.67	25.16	-.42	-.72	-.37	2.70	70MD	C644
C645	d	63.29	55.91X	25.12	63.05	55.40X	24.83	-.24	-.52	-.29	2.43	70AC	C645
C656	#	64.28	58.49	25.08	63.98	57.89	25.43	-.30	-.60	-.22	2.38	70SA	C656
C657	d	64.34	57.80	25.04	64.21	57.31	25.23	-.13	-.49	-.31	2.89	70AC	C657
C660	d	63.77	55.85X	25.09	63.55	55.35X	25.37	-.22	-.49	-.23	2.33	70AC	C660
C662	•	64.81	58.44	25.00	64.34	57.87	25.50	-.26	-.56	-.16	2.34	70SP	C662
C672	d	65.94X	59.82	27.21X	65.69X	59.21	26.91X	-.25	-.61	-.30	2.75	70GC	C672
C675	d	64.21	58.53	25.34	63.90	57.90	25.18	-.31	-.64	-.36	2.78	70AC	C675

X, Y, Z SPACE ANALYSIS, ADJUSTED DATA

COLOR * COLOR DIFFERENCE

FOR PAINT CHIPS

LAB CODE	F	SAMPLE D13 MEAN X	MEAN Y	MEAN Z	SAMPLE D14 MEAN X	MEAN Y	MEAN Z	DIFFERENCE D14 - D13 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C700	G	64.11	58.54	25.43	63.95	58.07	25.33	-.15	-.47	-.15	2.34	70DH	C700
C707	G	62.64X	56.78*	25.37	62.15X	56.04*	25.37	-.49 *	-.73	-.20	2.18	70SA	C707
C716	#	63.76	58.14	25.25	63.51	57.69	25.19	-.24	-.45	-.06	1.62	70ZE	C716
C717A	*	65.01	58.87	25.73	64.71	58.24	25.49	-.30	-.62	-.24	2.55	70SP	C717A
C717B	*	64.80	58.69	25.66	64.53	58.12	25.47	-.27	-.57	-.19	2.36	70SP	C717B
C718A	G	64.52	58.06	25.33	64.59	57.81	25.33	.07 *	-.25 *	.00	2.10	70AC	C718A
C718B	G	64.49	58.00	25.39	64.49	57.65	25.33	.01 *	-.35	-.06	2.45	70SA	C718B
C719C	G	63.78	58.67	25.41	63.56	58.11	25.29	-.22	-.57	-.12	2.49	70KC	C719C
C720A	*	64.99	58.74	25.78	64.80	58.26	25.78	-.20	-.48	.01	2.03	70SP	C720A
C720B	*	65.04	58.80	25.78	64.82	58.28	25.78	-.22	-.51	.03	2.07	70SP	C720B
C721	#	63.16*	56.46*	27.43X	63.10	56.15*	27.44X	-.06	-.32	-.01	1.78	70KS	C721
C722	G	63.81	57.98	25.50	63.54	57.42	25.24	-.27	-.56	-.06	2.17	70AC	C722
C723	G	64.43	58.91	25.61	64.19	58.40	25.58	-.25	-.52	-.03	1.95	70MD	C723
C724	G	64.00	58.61	25.50	63.82	58.13	25.42	-.18	-.48	-.14	2.25	70SA	C724
C726	G	65.08	60.09*	26.50X	64.09	59.37	26.02*	-.39	-.72	-.47 *	2.85	70SA	C726
C727A	*	67.26X	61.09X	27.22X	66.97X	60.48X	26.98X	-.29	-.61	-.24	2.46	70SP	C727A
C727B	*	64.99	59.17	25.96	64.66	58.51	25.61	-.33	-.67	-.37	2.80	70SP	C727B
C741	G	63.83	58.01	25.43	63.69	57.55	25.39	-.14	-.46	-.06	2.28	70SA	C741
GRAND MEANS		64.16	58.53	25.60	63.94	57.99	25.37	-.22	-.53	-.15	2.34		
SD OF MEANS		.47	.68	.26	.48	.69	.31	.10	.11	.12	.38		
INCLUDED LABS FOR THIS MEAN		65	64	62	65	64	63	67	68	68	68		

X, Y, Z SPACE ANALYSIS, ADJUSTED DATA
COLOR • COLOR DIFFERENCE
FOR PAINT CHIPS

LAB CODE	F	SAMPLE D15 MEAN X	MEAN Y	MEAN Z	SAMPLE D16 MEAN X	MEAN Y	MEAN Z	DIFFERENCE D16 - D15 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C157	G	8.77	11.82	13.44	8.52	11.72	12.76	-.25 *	-.11 *	-.68 *	2.43	70GE	C157
C162	G	9.14	12.02	13.34	9.02	12.03	13.22	-.11	.01	-.62	2.25	70DC	C162
C251	G	8.90	11.82	13.07	8.90	12.02	12.60	.00	.20	-.47	2.07	70SA	C251
C253	G	8.72	11.57	12.90	8.58	11.54	11.97	-.14	-.03	-.63	2.31	70GC	C253
C278	G	9.09	11.71	13.88*	9.09	11.86	13.49	.00	.15	-.39	2.05	70NE	C278
C407	G	9.29	12.18	13.47	9.23	12.23	12.90	-.06	.05	-.57	2.32	70BL	C407
C414	G	8.83	11.79	12.96	8.93	12.02	12.64	.10	.23	-.35	2.46	70MD	C414
C416A	G	8.40*	11.26*	12.16*	8.39*	11.36*	11.71*	-.01	.11	-.47	2.33	70IB	C416A
C416B	G	8.63	11.61	12.71	8.58	11.67	12.17	-.05	.06	-.54	2.30	70GE	C416B
C418	G	9.21	12.26	13.49	9.34	12.54*	13.20	.14	.28	-.29	2.44	70CE	C418
C422	G	8.77	11.66	12.95	8.82	11.82	12.09	.06	.15	-.44	2.55	70SA	C422
C424	G	9.20	12.16	13.81	9.27	12.35	13.21	.07	.18	-.40	2.36	70CA	C424
C428	G	8.64	11.63	12.93	8.77	11.88	12.21	.13	.25	-.32	2.58	70BB	C428
C437	G	8.92	11.85	12.80	8.91	11.96	12.32	-.01	.11	-.49	2.33	70GC	C437
C443	G	9.16	12.06	13.35	9.14	12.17	12.85	-.02	.12	-.50	2.34	70CL	C443
C444	G	8.91	11.83	13.10	8.96	12.00	12.67	.05	.17	-.43	2.44	70GE	C444
C446	G	8.95	11.90	12.97	9.10	12.17	12.70	.15	.27	-.27	2.47	70GE	C446
C451	G	8.88	11.73	13.06	8.98	11.95	12.74	.10	.22	-.34	2.37	70AC	C451
C459	G	8.71	11.60	12.94	8.84	11.85	12.65	.14	.25	-.28	2.46	70GE	C459
C460	G	8.40*	11.29*	12.63	8.64	11.64	12.42	.23	.35	-.15	2.74	70GE	C460
C462A	#	8.64	11.61	12.48	8.74	11.81	12.08	.10	.20	-.40	2.69	70HB	C462A
C463	G	8.90	11.85	13.20	9.06	12.15	12.91	.16	.29	-.29	2.67	70ZD	C463
C469	G	9.59X	12.66X	14.39X	9.45*	12.65*	13.79*	-.15	-.02	-.59	2.09	70GE	C469
C470	G	8.77	11.63	13.06	8.72	11.71	12.60	-.05	.07	-.48	2.08	70DH	C470
C472	G	9.16	12.14	13.71	9.19	12.30	13.31	.03	.16	-.40	2.14	70ZD	C472
C473	G	8.79	11.64	13.22	8.78	11.76	12.79	-.00	.12	-.43	2.12	70DH	C473
C474	G	9.18	11.97	13.48	9.09	12.01	12.66	-.09	.03	-.53	2.12	70SA	C474
C476	G	9.03	11.99	13.34	8.86	11.93	12.68	-.17 *	-.07 *	-.66 *	2.21	70SA	C476
C480	G	8.38*	11.32	12.24*	8.53	11.58	11.97	.14	.27	-.27	2.52	70HB	C480
C481	G	8.82	11.74	12.87	8.92	12.04	12.32	.10	.30	-.35	2.74	70BB	C481
C482	G	8.49	11.36	12.24*	8.53	11.52	11.84*	.04	.16	-.41	2.34	70GC	C482
C483	G	8.92	11.95	13.01	8.93	12.15	12.59	.01	.20	-.41	2.50	70SL	C483
C495	G	8.90	11.80	13.45	9.17	12.18	13.35	.27	.38	-.10	2.74	70KS	C495
C496A	G	8.99	11.92	13.20	9.18	12.22	12.98	.19	.30	-.22	2.52	70GE	C496A
C499C	X	9.33	12.37*	13.41	9.06	12.25	12.17	-.27 *	-.12 *	-.93 X	3.14X	70BL	C499C
C508	G	8.60	11.52	12.81	8.65	11.70	12.44	.05	.18	-.38	2.26	70GE	C508
C511	G	8.82	11.75	13.10	8.84	11.90	12.68	.02	.14	-.41	2.19	70DB	C511
C512	#	8.56	11.37	12.99	8.72	11.66	12.77	.16	.29	-.21	2.35	70AC	C512
C514B	•	8.68	11.69	12.94	8.68	12.01	12.73	.20	.32	-.21	2.64	70SP	C514B
C524	G	9.11	12.01	13.36	9.20	12.23	13.06	.09	.22	-.30	2.15	70GE	C524
C526	G	8.90	11.79	13.42	8.92	11.95	13.03	.02	.16	-.38	2.14	70KS	C526
C528	G	8.87	11.83	13.21	8.85	11.93	12.74	-.02	.11	-.47	2.19	70MD	C528
C529	G	8.85	11.85	13.20	8.83	11.95	12.80	-.02	.11	-.46	2.16	70DH	C529
C534	G	8.99	11.86	13.15	9.03	12.06	12.82	.04	.19	-.33	2.11	70MD	C534
C536	G	9.01	11.90	12.95	9.02	12.02	12.54	.01	.12	-.42	2.11	70AC	C536
C540	G	9.43*	12.39*	13.52	9.39	12.47	13.02	-.04	.07	-.50	2.13	70GE	C540
C543	#	8.71	11.69	12.99	8.82	11.94	12.23	.11	.25	-.32	2.46	70HB	C543
C545	G	8.70	11.59	13.04	8.79	11.80	12.68	.09	.21	-.36	2.40	70SA	C545
C549	G	8.78	11.68	13.14	8.66	11.68	12.57	-.12	.00	-.57	2.16	70DH	C549
C552	G	8.57	11.53	12.29*	8.58	11.67	11.80*	.01	.14	-.45	2.39	70HN	C552
C608	G	9.75X	12.77X	13.74	9.83X	12.98X	13.36	.08	.21	-.35	2.21	70GC	C608
C613	G	7.85X	11.30*	11.15X	8.03X	11.60	10.92X	.18	.30	-.23	2.72	70MD	C613
C627	G	8.96	11.97	13.25	9.15	12.27	12.99	.18	.30	-.26	2.66	70SA	C627
C630	G	8.92	11.89	13.17	9.18	12.26	13.03	.26	.37	-.14	2.81	70KS	C630
C631	G	8.85	11.72	13.07	9.00	11.97	12.80	.15	.26	-.27	2.49	70AC	C631
C632	G	8.88	11.74	13.15	9.04	12.01	12.88	.16	.27	-.25	2.43	70AC	C632
C638	G	8.54	11.57	12.93	8.69	11.77	12.10	.15	.20	-.35	3.01*	70GC	C638
C644	G	8.69	11.56	12.71	8.79	11.78	12.36	.10	.21	-.35	2.43	70MD	C644
C645	G	9.11	11.93	12.84	9.21	12.12	12.48	.09	.19	-.35	2.39	70AC	C645
C656	#	9.01	11.97	13.15	9.11	12.19	12.81	.10	.22	-.34	2.37	70SA	C656
C657	G	8.87	11.82	13.20	9.01	12.06	12.88	.14	.24	-.32	2.57	70AC	C657
C660	G	9.27	12.19	13.24	9.36	12.35	12.83	.08	.16	-.41	2.52	70AC	C660
C662	•	8.84	11.85	13.15	8.97	12.09	12.81	.13	.24	-.34	2.59	70SP	C662
C672	G	8.69	11.48	12.49	8.84	11.73	12.18	.15	.25	-.30	2.68	70GC	C672
C675	G	9.02	11.91	13.24	9.03	12.03	12.78	.00	.12	-.46	2.25	70AC	C675

MCCA COLLABORATIVE REFERENCE PROGRAM
X, Y, Z SPACE ANALYSIS, ADJUSTED DATA
COLOR * COLOR DIFFERENCE
FOR PAINT CHIPS

LAB CODE	F	SAMPLE D15 MEAN X	MEAN Y	MEAN Z	SAMPLE D16 MEAN X	MEAN Y	MEAN Z	DIFFERENCE D16 - D15 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C700	@	8.71	11.64	12.95	8.97	12.01	12.81	.26	.37	-.14	2.80	70DH	C700
C707	@	9.92X	12.62X	14.40X	10.11X	12.91X	14.26X	.19	.29	-.14	2.06	70SA	C707
C716	#	13.80X	11.96	13.30	9.38	12.21	12.95	-4.42 X	.25	-.36	83.39X	70ZE	C716
C717A	*	9.09	12.07	13.52	9.16	12.26	13.16	.07	.19	-.36	2.21	70SP	C717A
C717B	*	8.92	11.89	13.37	9.09	12.18	13.12	.16	.29	-.25	2.47	70SP	C717B
C718A	@	8.84	11.78	13.14	8.94	11.99	12.80	.10	.21	-.34	2.40	70AC	C718A
C718B	@	8.85	11.78	13.13	9.09	12.16	13.04	.24	.38	-.14	2.66	70SA	C718B
C719C	@	9.18	12.20	13.45	9.33	12.48	13.18	.15	.28	-.27	2.45	70KC	C719C
C720A	*	8.92	11.91	13.31	9.05	12.16	12.99	.12	.24	-.32	2.48	70SP	C720A
C720B	*	8.89	11.91	13.27	9.04	12.17	12.99	.15	.26	-.29	2.53	70SP	C720B
C721	#	10.02X	12.97X	13.80	10.20X	13.24X	13.59	.18	.28	-.27	2.58	70KS	C721
C722	@	8.91	11.77	13.10	9.02	11.99	12.76	.11	.23	-.34	2.43	70AC	C722
C723	@	8.65	11.56	12.96	8.87	11.91	12.79	.22	.36	-.16	2.65	70MD	C723
C724	@	8.82	11.75	13.01	9.03	12.07	12.79	.20	.32	-.21	2.67	70SA	C724
C726	@	9.02	11.92	13.51	9.19	12.24	13.27	.17	.32	-.24	2.48	70SA	C726
C727A	*	9.19	12.34*	14.00*	9.29	12.57*	13.64*	.11	.22	-.36	2.47	70SP	C727A
C727B	*	8.82	11.76	13.45	8.85	11.91	13.02	.03	.16	-.41	2.22	70SP	C727B
C741	@	8.93	11.89	13.22	8.95	12.00	12.81	.02	.11	-.41	2.10	70SA	C741
GRAND MEANS		8.88	11.79	13.08	8.95	11.99	12.72	.07	.19	-.37	2.40		
SD OF MEANS		.22	.24	.39	.24	.26	.42	.11	.11	.13	.22		
INCLUDED LABS FOR THIS MEAN		64	65	65	65	66	66	68	68	68	68		

NCSA COLLABORATIVE REFERENCE PROGRAM
L, a, b SPACE ANALYSIS, ADJUSTED DATA
COLOR * COLOR DIFFERENCE
FOR PAINT CHIPS

LAB CODE	F	SAMPLE D13 MEAN L	MEAN A	MEAN B	SAMPLE D14 MEAN L	MEAN A	MEAN B	DIFFERENCE D14 - D13 ΔL	ΔA	ΔH	ΔE	INST CODE	LAB
C121	G	76.46	15.91	34.05*	76.16	16.86	34.49*	-.30	.95 *	-.20	1.02	70HM	C121
C148	G	76.59	16.50	33.81	76.24	17.35	33.71	-.35	.85	-.10 *	.92	70HF	C148
C152	G	76.96	16.52	33.81	76.57	17.31	33.61	-.40	.80	-.20	.91	70HA	C152
C166	G	76.80	16.28	33.83	76.45	17.02	33.53	-.35	.75	-.30	.88	70HA	C166
C183	G	78.61X	15.88	34.06	78.10X	16.80	33.86	-.51 *	.92	-.20	1.07*	70HA	C183
C223	G	75.92	16.37	33.29	75.55	17.14	33.06	-.37	.77	-.23	.89	70HA	C223
C241	G	79.11X	15.59	34.06	78.60X	16.56	34.36	-.51 *	.97 *	-.20	1.12*	70HF	C241
C256A	G	76.82	15.94	34.21	76.44	16.76	34.02	-.38	.82	-.19	.92	70HM	C256A
C256H	G	76.36	15.73	34.01	76.01	16.48	33.80	-.35	.75	-.21	.85	70HU	C256H
C288	G	78.23X	16.37	34.00	77.83X	17.19	34.29	-.41	.82	-.31	.96	70SC	C288
C291	G	76.74	16.33	33.98	76.39	17.08	33.48	-.35	.75	-.20	.85	70HA	C291
C317	G	76.61	16.28	34.10	76.31	17.08	33.90	-.30	.80	-.20	.88	70HM	C317
C325	G	75.95	15.17	32.97*	75.65	15.96	32.70*	-.30	.79	-.26	.88	70HR	C325
C356	G	76.69	16.67	34.15	76.39	17.37	33.96	-.30	.70	-.20	.79	70HM	C356
C380	G	77.06	16.42	34.20	76.67	17.16	34.06	-.40	.75	-.20	.87	70HA	C380
C382	G	76.71	15.14	33.75	76.31	15.94	33.56	-.40	.80	-.20	.91	70HA	C382
C390	G	76.59	17.91	33.69	76.19	18.80*	33.74	-.40	.90	-.15	.99	70HF	C390
C420A	G	76.25	16.78	34.26	75.90	17.58	34.06	-.35	.80	-.20	.89	70HF	C420A
C420H	G	76.46	17.14	34.31	75.86	17.84	34.01	-.60 X	.70	-.30	.97	70HF	C420B
C427	G	76.76	16.55	33.93	76.41	17.30	33.68	-.35	.75	-.30	.88	70HA	C427
C440	G	76.42	17.12	34.31	76.20	17.84	33.99	-.22 *	.72	-.32	.81	70HA	C440
C442	G	77.03	15.40	34.05	76.68	16.20	33.85	-.35	.80	-.20	.90	70HM	C442
C454	G	75.67	15.18	33.09	75.23*	16.07	32.90	-.44	.90	-.19	1.02	70HA	C454
C458	G	76.89	16.24	33.80	76.55	17.02	33.65	-.34	.78	-.21	.88	70HM	C458
C475	G	76.37	16.37	33.70	75.97	17.26	33.50	-.40	.88	-.20	.99	70HA	C475
C477	G	75.91	17.28	33.15	75.55	18.03	32.91	-.36	.76	-.24	.87	70HA	C477
C494	G	76.69	16.36	33.66	76.39	17.00	33.38	-.30	.64	-.15	.72*	70HA	C494
C496B	G	75.83	15.33	37.25X	75.60	16.06	37.05X	-.23	.72	-.18	.78	70GP	C496H
C499A	G	76.39	16.80	30.20X	76.14	17.49	29.91X	-.25	.70	-.30	.80	70HA	C499A
C499H	G	76.55	16.54	33.69	76.10	17.34	33.39	-.45	.80	-.30	.96	70HA	C499H
C506	G	76.77	16.75	33.70	76.48	17.50	33.50	-.30	.75	-.20	.83	70HF	C506
C514A	*	76.64	16.90	33.83	76.35	17.65	33.59	-.29	.75	-.24	.83	70SR	C514A
C517	G	76.11	15.24	33.52	75.81	16.03	33.32	-.30	.79	-.20	.86	70SC	C517
C538	G	78.43X	16.86	33.65	78.07X	17.57	32.60	-.35	.71	-.25	.83	70GX	C538
C541	G	75.91	17.00	33.07	75.56	17.79	32.83	-.35	.79	-.25	.90	70GP	C541
C543	#	76.79	15.22	33.62	76.49	16.00	33.39	-.30	.78	-.23	.86	70HA	C543
C546A	G	75.59*	17.76	33.66	75.29	16.55	33.36	-.30	.80	-.30	.90	70HQ	C546A
C546H	G	76.35	16.44	34.09	75.95	17.19	33.79	-.40	.75	-.30	.90	70HM	C546H
C547	G	75.47*	17.48	34.42	75.18*	18.35	34.13	-.29	.87	-.29	.96	70HQ	C547
C574	G	76.60	14.42*	32.47X	76.21	15.11*	32.18X	-.40	.69	-.30	.85	70HQ	C574
C600	G	76.47	18.53*	33.49	76.17	19.43*	32.99	-.30	.90	-.20	.97	70GD	C600
C620	G	76.57	16.18	34.13	76.23	16.68	33.90	-.34	.70	-.24	.81	70MG	C620
C628	G	76.72	15.41	33.66	76.32	16.07	33.43	-.41	.67	-.24	.82	70ME	C628
C633	G	76.71	17.00	33.41	76.36	17.66	33.06	-.35	.66	-.35 *	.82	70HA	C633
C655	G	76.54	15.87	33.60	76.17	16.09	33.71	-.37	.82	-.14	.91	70HU	C655
C677	G	76.02	16.50	33.66	75.37	17.31	33.55	-.65 X	.81	-.14	1.04	70SC	C677
C690	G	76.65	16.19	33.69	76.30	16.89	33.49	-.35	.70	-.20	.81	70HA	C690
C705	G	61.78X	4.38X	68.95X	61.25X	4.59X	67.35X	-.54 *	.21 X	-.68 X	.89	70SC	C705
C709	G	76.26	16.02	33.60	75.93	16.74	33.50	-.33	.71	-.30	.84	70SC	C709
C719A	G	76.18	14.41*	33.37	75.78	15.10*	33.57	-.40	.69	-.30	.85	70HA	C719A
C719B	G	76.86	16.94	34.24	76.61	17.64	33.81	-.25	.70	-.20	.77	70HA	C719H
C742	*	81.50X	21.35X	37.09X	81.31X	22.16X	37.88X	-.19 *	.81	-.01 X	.84	70SR	C742
GRAND MEANS		76.44	16.31	33.83	76.08	17.09	33.60	-.36	.78	-.23	.89		
SD OF MEANS		.39	.83	.42	.40	.84	.42	.07	.08	.06	.08		
INCLUDED LABS FOR THIS MEAN		44	48	45	44	48	45	47	48	48	49		

ASTM COLLABORATIVE REFERENCE PROGRAM

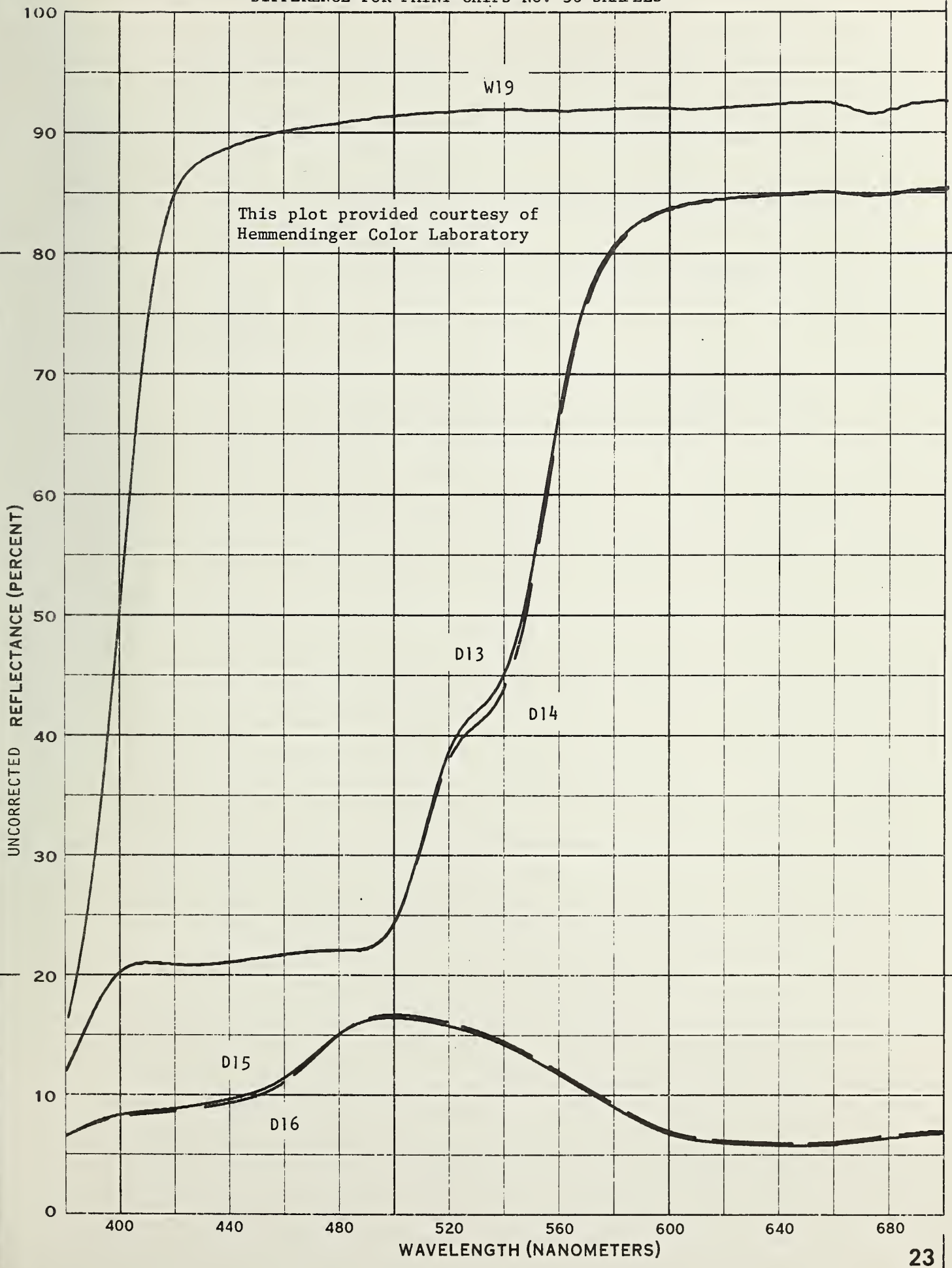
L, a, b SPACE ANALYSIS, ADJUSTED DATA

COLOR • COLOR DIFFERENCE

FOR PAINT CHIPS

LAB CODE	F	SAMPLE D15 MEAN L	MEAN A	MEAN B	SAMPLE D16 MEAN L	MEAN A	MEAN B	DIFFERENCE D16 - D15 ΔL	ΔA	ΔB	ΔE	INST CODE	LAB
C121	G	33.89	-14.65	2.26	34.19	-15.15	3.37	.30	-.50	1.10	1.24	70HM	C121
C148	G	34.50	-14.66	2.37	34.35	-15.06	3.37	.35	-.40	.99	1.13	70HF	C148
C152	G	34.49	-14.06	2.07	34.34	-14.66	3.11	-.15 X	-.60	1.04	1.21	70HA	C152
C166	G	34.23	-14.19	2.01	34.23	-14.79	3.10	.00 *	-.60	1.09	1.24	70HA	C166
C183	G	35.09	-15.95X	2.90*	34.89	-15.34	1.87	-.20 X	.61 X	-1.03 X	1.22	70HA	C183
C223	G	34.71	-14.48	2.19	34.91	-15.04	3.29	.20	-.55	1.10	1.25	70HA	C223
C241	G	35.06	-14.41	1.75	35.11	-14.97	2.87	.05	-.56	1.13 *	1.27	70HF	C241
C256A	G	33.94	-14.25	2.00	34.18	-14.72	3.10	.24	-.47	1.10	1.22	70HM	C256A
C256B	G	33.59	-13.57*	.09*	33.84	-14.02	1.74*	.25	-.45	1.04	1.16	70HU	C256B
C288	G	34.77	-14.33	1.75	34.98	-14.94	2.73	.20	-.61	1.03	1.22	70SC	C288
C291	G	34.45	-14.10	2.04	34.65	-14.60	3.43	.20	-.50	1.09	1.22	70HA	C291
C317	G	34.08	-14.23	2.35	34.48	-14.63	3.45	.40	-.40	1.10	1.24	70HM	C317
C325	G	34.36	-14.41	1.94	34.65	-15.21	2.89	.29	-.80 X	.98	1.30*	70HR	C325
C356	G	33.84	-13.66	2.04	34.14	-14.06	3.43	.30	-.40	1.09	1.20	70HM	C356
C380	G	34.15	-14.06	2.27	34.49	-14.56	3.36	.35	-.50	1.09	1.25	70HA	C380
C382	G	34.31	-14.34	2.00	34.51	-14.94	3.15	.20	-.60	1.09	1.26	70HA	C382
C390	G	34.50	-14.19	2.00	34.75	-14.59	3.10	.25	-.40	1.04	1.14	70HF	C390
C420A	G	34.13	-16.94X	1.25	34.63	-17.29X	2.24	.50	-.35	.99	1.17	70HF	C420A
C420B	G	34.16	-16.85X	1.21	34.56	-17.15X	2.21	.40	-.30 *	.99	1.11	70HF	C420B
C427	G	34.31	-14.05	2.27	34.51	-14.55	3.26	.20	-.50	.99	1.13	70HA	C427
C440	G	34.18	-14.50	2.04	34.55	-14.98	3.35	.37	-.48	1.01	1.18	70BA	C440
C442	G	34.01	-13.82	1.82	34.16	-14.32	2.51	.15	-.50	.99	1.12	70HM	C442
C454	G	34.87	-14.33	1.99	35.12	-14.97	3.06	.25	-.64	1.07	1.27	70HA	C454
C458	G	33.90	-14.04	1.99	34.13	-14.58	2.60	.24	-.53	1.01	1.17	70BM	C458
C475	G	34.45	-14.15	1.85	34.66	-14.72	2.22	.21	-.57	.99	1.16	70HA	C475
C477	G	34.57	-14.43	1.84	34.84	-15.00	2.61	.27	-.58	.97	1.16	70BA	C477
C494	G	34.36	-14.39	1.48	34.66	-14.88	2.56	.30	-.49	1.08	1.22	70HA	C494
C496B	G	33.64	-14.71	3.95X	33.85	-15.24	4.96X	.22	-.53	1.01	1.16	70GP	C496B
C499A	G	33.81	-14.49	-6.97X	34.26	-14.89	-5.93X	.45	-.40	1.04	1.20	70HA	C499A
C499B	G	34.28	-14.25	2.27	34.58	-14.70	3.26	.30	-.45	.99	1.13	70HA	C499B
C506	G	34.03	-14.24	2.22	34.58	-14.59	3.21	.55 *	-.35	.99	1.19	70HF	C506
C514A	•	34.38	-14.24	1.12	34.76	-14.63	2.12	.39	-.39	1.00	1.14	70SR	C514A
C517	G	33.97	-12.91X	.94	34.07	-13.55*	1.92	.10	-.64	.98	1.18	70SC	C517
C538	G	35.48*	-10.71X	-1.27X	35.68*	-11.21X	-.26X	.20	-.50	1.01	1.14	70GX	C538
C541	G	33.75	-13.59*	1.47	34.05	-13.98	2.45	.30	-.40	.98	1.10	70GP	C541
C543	G	34.18	-14.16	2.12	34.50	-14.67	3.14	.32	-.51	1.01	1.18	70HA	C543
C546A	G	33.56	-14.18	1.94	33.91	-14.68	2.40	.35	-.50	.99	1.16	70HQ	C546A
C546B	G	33.66	-14.17	2.21	34.01	-14.77	3.26	.35	-.60	1.05	1.26	70HM	C546B
C547	G	32.08X	-15.07*	1.94	32.14A	-15.81*	2.49	.06	-.74 *	1.05	1.29	70HQ	C547
C574	G	37.81X	-11.86X	1.92	38.10A	-12.31X	2.21	.30	-.45	.89 *	1.04*	70HQ	C574
C600	G	34.78	-14.72	2.18	35.03	-15.22	3.18	.25	-.50	1.00	1.15	70GD	C600
C620	G	33.55	-14.27	1.93	33.92	-14.75	2.35	.37	-.48	.99	1.16	70MG	C620
C628	G	34.34	-14.25	1.90	34.87	-14.61	2.56	.53	-.36	.95	1.15	70ME	C628
C633	G	34.33	-14.20	2.26	34.87	-14.63	3.32	.34	-.43	1.04	1.18	70BA	C633
C655	G	34.31	-13.60*	1.41	34.48	-14.09	2.12	.14	-.49	1.01	1.13	70HU	C655
C677	G	34.49	-12.95X	1.15	34.47	-13.48*	2.20	-.02 *	-.53	1.05	1.17	70SC	C677
C690	G	33.72	-14.13	2.07	33.92	-14.73	3.17	.20	-.60	1.10	1.27	70HA	C690
C705	G	12.20X	-1.93X	1.73	12.54A	-2.01X	2.68	.34	-.08 X	.98	1.05*	70SC	C705
C709	G	34.96	-14.17	1.99	35.39*	-14.57	2.58	.43	-.40	.99	1.15	70SC	C709
C719A	G	34.11	-14.17	1.96	34.45	-14.76	2.31	.35	-.59	1.03	1.24	70HA	C719A
C719B	G	34.10	-14.46	2.03	34.55	-14.86	3.02	.45	-.40	.99	1.16	70HA	C719B
C742	•	32.68X	-13.62	-2.07X	32.62A	-13.88	-1.55X	-.06 *	-.27 *	1.01	1.05*	70SR	C742
GRAND MEANS		34.26	-14.24	1.81	34.52	-14.71	2.80	.28	-.50	1.03	1.19		
SD OF MEANS		.44	.31	.46	.41	.44	.49	.13	.09	.05	.06		
INCLUDED LABS FOR THIS MEAN		46	41	46	46	44	46	47	46	48	49		

SPECTROPHOTOMETRIC CURVES OF COLOR AND COLOR DIFFERENCE FOR PAINT CHIPS NO. 30 SAMPLES



Notes on Specific Laboratory Results for Near White Papers

C162	- Reporting or measurement problem on mean Z for both samples
C222	- Reporting or measurement problem on mean a for both samples
C226	- Reported insufficient data to be analyzed in this report
C662, C717A, C717B, C720A, C720B, C727A C727B	- Used illuminant D65
C716	- Data received too late to be included in Grand Mean Statistics

X, Y, Z SPACE ANALYSIS, NORMAL DATA

COLOR • COLOR DIFFERENCE

FOR NEAR WHITE PAPERS

LAB CODE	F	SAMPLE P03 MEAN X	MEAN Y	MEAN Z	SAMPLE P04 MEAN X	MEAN Y	MEAN Z	DIFFERENCE P04 - P03 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C162	G	80.36*	81.98X	60.10X	77.93*	79.44X	75.70X	-2.41	-2.55	-4.44	4.49	71DC	C162
C244	G	77.74	78.69	73.39	75.02	76.13	70.70	-2.72	-2.56	-4.69	4.32	71ZE	C244
C250	G	77.87	79.24	73.31	75.30	76.37	70.77	-2.57	-2.86	-4.74	5.47	71ZF	C250
C313	G	77.65	78.51	73.99	74.80	75.50	71.29	-2.79	-3.01	-4.70	5.12	71SA	C313
C446	G	76.91	78.42	73.13	74.30	75.08	70.57	-2.61	-2.74	-4.57	4.76	71GE	C446
C662	•	75.63	79.02	69.87X	73.15	76.28	65.57X	-2.48	-2.74	-4.30	4.92	71SP	C662
C716	#	76.33	77.77	74.33	73.47	74.77	69.76	-2.87	-3.00	-4.77	4.95	71ZE	C716
C717A	•	75.76	79.19	70.33X	73.06	76.26	65.96X	-2.70	-2.93	-4.37	4.81	71SP	C717A
C717B	•	75.98	78.91	70.49X	73.81	77.04	66.61X	-2.17	-1.86 *	-3.88 *	3.63	71SP	C717B
C720A	•	75.61	79.04	69.93X	72.92	76.10	65.48X	-2.69	-2.93	-4.45	4.96	71SP	C720A
C720B	•	75.36	78.80	69.70X	72.72	75.89	65.42X	-2.66	-2.90	-4.36	4.87	71SP	C720B
C727A	•	75.85	79.28	70.25X	73.28	76.48	65.91X	-2.58	-2.81	-4.32	4.77	71SP	C727A
C727B	•	75.81	79.24	70.34X	73.27	76.48	66.25X	-2.54	-2.77	-4.25	4.69	71SP	C727B
GRAND MEANS		78.11	78.72	73.31	75.49	73.92	70.63	-2.62	-2.74	-4.63	4.83		
SD OF MEANS		1.31	.37	.36	1.42	.40	.32	.15	.20	.12	.47		
INCLUDED LABS FOR THIS MEAN		5	4	4	5	4	4	5	5	5	5		

MCCA COLLABORATIVE REFERENCE PROGRAM
L, a, b SPACE ANALYSIS, NORMAL DATA
COLOR • COLOR DIFFERENCE
FOR NEAR WHITE PAPERS

LAB CODE	F	SAMPLE P03 MEAN L	MEAN A	MEAN B	SAMPLE P04 MEAN L	MEAN A	MEAN B	DIFFERENCE P04 - P03 ΔL	ΔA	ΔB	ΔE	INST CODE	LAB
C105	6	89.00	-.40	12.17	87.34	-.14	13.49	-1.66	.26	1.33	2.14	71HM	C105
C122	6	88.66	.20	11.97	86.93	.54	13.35	-1.73	.34	1.38	2.25	71SC	C122
C128	6	88.60	.01	12.67	86.81	.26	13.29	-1.79	.25	1.22	2.19	71HM	C128
C148	6	90.13	-.64	12.22	88.41	-.42	13.58	-1.72	.22	1.36	2.21	71HF	C148
C150	6	89.55	-.16	11.99	87.95	.10	13.25	-1.60	.26	1.26	2.06	71HA	C150
C213	6	88.19	-.24	11.89	86.62	.02	13.04	-1.57	.26	1.15	1.97	71SC	C213
C222	X	89.53	-1.40*	11.91	89.13	-1.05*	14.32*	-.39 X	.35	.41 X	.67X	71HA	C222
C230	6	90.42	-.40	11.93	89.11	.24	13.20	-1.31	.64 X	1.27	1.93	71HA	C230
C262	6	88.03	-.20	11.81	86.19	.09	12.90	-1.83	.29	1.29	2.26	71HR	C262
C285	6	89.34	-.84	12.47	87.72	-.59	13.78	-1.62	.24	1.31	2.10	71MG	C285
C301	6	88.84	-.00	12.19	87.11	.18	13.47	-1.72	.18	1.28	2.16	71HM	C301
C320	6	90.09	-.89	11.85	88.01	-.72	12.97	-1.48	.17	1.10	1.85	71HA	C320
C324	6	90.49	.33	11.87	89.39	.04	12.77	-1.10 *	.31	1.10	1.59*	71HA	C324
C352	6	90.18	-.45	11.85	88.81	-.22	12.94	-1.36	.24	1.11	1.77	71HA	C352
C442	6	89.02	-.48	11.88	87.37	-.27	13.10	-1.65	.21	1.23	2.07	71HM	C442
C456	6	87.72	-.15	12.10	86.07	.11	13.31	-1.65	.26	1.20	2.06	71HA	C456
C571	6	88.40	.36	12.47	86.57	.77	13.75	-1.84	.40	1.28	2.28	71HA	C585
C585	6	86.79*	.05	11.84	84.75*	.31	13.07	-2.04	.26	1.23	2.40	71HA	C585
C670	6	89.13	-.78	12.75	87.71	-.64	14.06	-1.43	.14	1.26	1.91	71ME	C670
C702	6	88.07	.03	12.19	85.82	.40	13.37	-2.25 *	.37	1.18	2.57*	71HA	C702
C713	6	90.91	.24	12.97*	89.10	.30	14.22*	-1.80	.06 *	1.26	2.20	71HA	C713
GRAND MEANS		89.08	-.22	12.10	87.42	.05	13.35	-1.66	.25	1.24	2.10		
SD OF MEANS		1.07	.38	.33	1.25	.42	.39	.26	.08	.08	.22		
INCLUDED LABS FOR THIS MEAN		20	20	20	20	20	20	20	19	20	20		

EXPLANATION OF DATA FOR WHITE SAMPLE FOR NEAR WHITE PAPERS

Specimens of a white calibration sample (Paint Chips) were distributed to the participants along with the two sets of eight near white paper, and each participant was asked to return measurement data for the white calibration sample (Paint Chips), reporting results in the same manner as for the near white papers.

As a first step, three laboratories were selected to serve as "reference" laboratories for the purposes of this analysis and the average of their X, Y, Z values for the white sample were computed. Next, the ratios of the participants data to the combined reference laboratory values were calculated for each participant (transformed to X, Y, Z space if necessary). These ratios are shown in the White Sample Analysis table.

Two observations can be made about the data in the White Sample Analysis tables. First, the participants as a whole tend to be high compared with the combined average values obtained by the selected reference laboratories. Second , a few participants had noticeably extreme values for one or more of the components and these participants especially should look to the cause.

Next, the ratios in the White Sample Analysis tables were used to "adjust" the data of the normal data tables to obtain the adjusted data table values. The adjustment consisted of dividing the X, Y, Z values of the normal data tables by the respective ratios in the White Sample Analysis tables.

The significant change is the adjusted data tables is in the SD OF MEANS. Comparison of these among-laboratory standard deviations with those in the normal data tables, shows considerable reduction for X, Y. Z. Thus part, at least, of the disagreement among participants is due to errors in standardization that could be corrected through use of an agreed-upon white standard. There is no similar significant change for ΔX, ΔY, and ΔZ.

REPORT NO. 30

NCSA COLLABORATIVE REFERENCE PROGRAM
WHITE SAMPLE ANALYSIS FOR NEAR WHITE PAPERS
X, Y, Z LABORATORIES

1979-1980

LAB CODE	RATIO--(LAB/COMBINED) X	Y	Z	INST CODE	PERCENT FROM COMBINED X	Y	Z
C162	1.0129	1.0090	1.0162	71DC	1.29	.90	1.82
C244	1.0024	.9977	1.0096	71ZE	.24	-.23	.96
C250	1.0106	1.0043	1.0114	71ZF	1.06	.43	1.14
C313	1.0086	1.0038	1.0125	71SA	.86	.38	1.25
C446	1.0004	.9998	1.0051	71GE	.04	-.02	.51
C662	.9713	.9944	.9254	71SP	-2.87	-.56	-7.46
C716	.9979	.9955	1.0034	71ZE	-.21	-.45	.34
C717A	.9771	1.0004	.9345	71SP	-2.29	.04	-6.55
C717B	.9806	1.0042	.9355	71SP	-1.94	.42	-6.35
C720A	.9726	.9959	.9275	71SP	-2.74	-.41	-7.25
C720B	.9930	.9935	.9264	71SP	-.70	-.65	-7.36
C727A	.9775	1.0012	.9356	71SP	-2.25	.12	-6.64
C727B	.9754	.9988	.9325	71SP	-2.46	-.12	-6.75

WHITE SAMPLE ANALYSIS FOR NEAR WHITE PAPERS
L, a, b LABORATORIES

LAB CODE	RATIO--(LAB/COMBINED) X	Y	Z	INST CODE	PERCENT FROM COMBINED X	Y	Z
C105	1.0011	.9977	1.0088	71BM	.11	-.23	.88
C122	.9994	.9967	1.0062	71BC	-.06	-.33	.62
C128	.9984	.9956	1.0036	71BM	-.16	-.44	.36
C148	1.0068	1.0040	1.0166	71AF	.68	.40	1.06
C150	1.0037	1.0015	1.0127	71AA	.37	.15	1.27
C213	.9900	.9872	.9906	71BC	-1.00	-1.28	-.34
C222	.9939	.9896	.9954	71AA	-.61	-1.04	-.66
C230	1.0012	.9989	1.0077	71AA	.12	-.11	.77
C262	1.0108	1.0078	1.0203	71AA	1.08	.78	2.03
C285	.9863	.9877	.9806	71MG	-1.37	-1.23	-1.94
C301	.9984	.9956	1.0067	71AM	-.16	-.44	.67
C320	1.0146	1.0114	1.0150	71AA	1.46	1.14	1.50
C324	1.0061	1.0030	1.0142	71AA	.61	.30	1.42
C352	1.0100	1.0072	1.0185	71AA	1.00	.72	1.85
C442	.9978	.9956	1.0036	71AM	-.22	-.44	.36
C456	1.0061	1.0031	1.0137	71AA	.61	.31	1.37
C571	.9855	.9816	.9792	71AA	-1.45	-1.84	-2.08
C585	1.0088	1.0055	1.0178	71AA	.88	.55	1.78
C670	.9905	.9915	.9854	71ME	-.95	-.85	-1.46
C702	1.0000	.9967	1.0070	71AA	.00	-.33	.70
C713	1.0610	1.0552	1.0637	71AA	6.10	5.52	6.37

X, Y, Z SPACE ANALYSIS, ADJUSTED DATA
COLOR = COLOR DIFFERENCE
FOR NEAR WHITE PAPERS

LAB CODE	F	SAMPLE P03 MEAN X	MEAN Y	MEAN Z	SAMPLE P04 MEAN X	MEAN Y	MEAN Z	DIFFERENCE P04 - P03 ΔX	ΔY	ΔZ	ΔE	INST CODE	LAB
C162	@	79.34*	81.25*	78.71X	76.96A	78.73*	74.35X	-2.38	-2.52	-4.37	4.47	71DC	C162
C244	@	77.55	78.88	74.37	74.84	76.31	70.02	-2.71	-2.57	-4.65	4.31	71ZE	C244
C250	@	77.05	78.90	74.53	74.51	76.04	69.98	-2.54	-2.85	-4.69	5.45	71ZF	C250
C313	@	76.99	78.22	75.05	74.22	75.22	70.41	-2.77	-3.00	-4.64	5.10	71SA	C313
C446	@	76.88	78.43	74.79	74.27	75.69	70.21	-2.61	-2.74	-4.54	4.75	71GE	C446
C662	*	77.87	79.47	75.31	75.32	76.71	70.85	-2.55	-2.75	-4.65	5.06	71SP	C662
C716	#	76.49	78.13	74.23	73.62	75.11	69.53	-2.87	-3.01	-4.75	4.94	71ZE	C716
C717A	*	77.54	79.17	75.27	74.78	76.24	70.59	-2.76	-2.93	-4.68	4.91	71SP	C717A
C717B	*	77.49	78.58	75.28	75.27	76.72	71.13	-2.21	-1.86 *	-4.14	3.69	71SP	C717B
C720A	*	77.74	79.37	75.48	74.67	76.42	70.60	-2.77	-2.95	-4.80	5.08	71SP	C720A
C720B	*	75.92	79.32	75.33	73.23	76.39	70.62	-2.68	-2.92	-4.71	4.98	71SP	C720B
C727A	*	77.59	79.19	75.25	74.93	76.38	70.61	-2.64	-2.80	-4.62	4.88	71SP	C727A
C727B	*	77.73	79.34	75.60	75.12	76.57	71.05	-2.61	-2.77	-4.56	4.80	71SP	C727B
GRAND MEANS		77.56	79.14	74.79	74.46	76.40	70.15	-2.60	-2.74	-4.58	4.81		
SD OF MEANS		1.03	1.22	.19	.28	1.36	.20	.15	.20	.13	.47		
INCLUDED LABS FOR THIS MEAN		5	5	4	4	5	4	5	5	5	5		

L, a, b SPACE ANALYSIS, ADJUSTED DATA
COLOR * COLOR DIFFERENCE
FOR NEAR WHITE PAPERS

LAB CODE	F	SAMPLE P03 MEAN L	MEAN A	MEAN B	SAMPLE P04 MEAN L	MEAN A	MEAN B	DIFFERENCE P04 - P03 ΔL	ΔA	ΔB	ΔE	INST CODE	LAB
C105	G	89.10	-.93	12.73	87.44	-.06	14.03	-1.66	.27	1.30	2.13	71HM	C105
C122	G	88.81	-.23	12.43	87.08	.11	13.82	-1.74	.35	1.36	2.24	71SC	C122
C128	G	88.80	-.42	12.49	87.00	-.16	13.70	-1.80	.26	1.21	2.18	71HM	C128
C148	G	89.95	-1.08	12.52	88.23	-.85	13.86	-1.72	.22	1.34	2.19	71HF	C148
C150	G	89.48	-.51	12.54	87.88	-.24	13.78	-1.60	.27	1.24	2.04	71HA	C150
C213	G	88.76	-.67	12.44	87.17	-.40	13.57	-1.59	.27	1.14	1.97	71SC	C213
C222	X	89.99	-2.08X	12.15	89.00	-1.72X	12.57X	-.39 X	.36	.41 X	.67X	71HA	C222
C230	G	90.47	-.78	12.39	89.16	-.14	13.04	-1.31	.64 X	1.25	1.92	71HA	C230
C262	G	87.69	-.65	12.18	85.86	-.36	13.43	-1.83	.30	1.26	2.24	71HR	C262
C285	G	89.90	-.62	12.19	88.27	-.38	13.53	-1.64	.24	1.34	2.13	71MG	C285
C301	G	89.04	-.43	12.77	87.31	-.25	14.03	-1.73	.19	1.26	2.15	71HM	C301
C320	G	89.58	-1.38*	11.98*	88.11	-1.21*	13.07*	-1.47	.17	1.09	1.84	71HA	C320
C324	G	90.36	-.17	12.25	89.20	.15	13.31	-1.10 *	.32	1.08	1.57*	71HA	C324
C352	G	89.85	-.89	12.55	88.80	-.65	13.44	-1.36	.24	1.09	1.75	71HA	C352
C442	G	89.21	-.82	12.30	87.56	-.60	13.52	-1.65	.22	1.21	2.06	71HM	C442
C456	G	87.59	-.61	12.00	85.94	-.34	13.78	-1.65	.27	1.19	2.04	71HA	C456
C571	G	89.23	-.25	12.47	87.37	.17	13.76	-1.86	.42	1.30	2.30	71HA	C571
C585	G	86.55*	-.45	12.40	84.51*	-.18	13.59	-2.04	.27	1.19	2.38	71HA	C585
C670	G	89.52	-.63	12.34	88.08	-.49	13.82	-1.44	.14	1.28	1.93	71ME	C670
C702	G	88.21	-.49	12.72	85.96	-.11	13.88	-2.25 *	.38	1.16	2.56*	71HA	C702
C713	G	88.49	-.62	13.01*	86.74	-.54	14.22	-1.76	.07 *	1.21	2.13	71HA	C713
GRAND MEANS		89.03	-.63	12.46	87.37	-.35	13.69	-1.66	.26	1.22	2.09		
SD OF MEANS		.98	.29	.24	1.17	.34	.27	.25	.08	.09	.22		
INCLUDED LABS FOR THIS MEAN		20	20	20	20	20	20	20	19	20	20		

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

Collaborative Reference Programs provide participating laboratories with the means for checking periodically the level and uniformity of their testing in comparison with that of other participating laboratories. An inmportant by-product of the programs is the provision of realistic pictures of the state of the testing art. This is one of the periodic reports showing averages for each participant, within and between laboratory variability, and other information for participants and standards committees.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

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